THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893,

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ELECTRIC LIGHTING OF MINES.

THE disastrous explosion which has recently occurred at the Park Slip Colliery, Tondu, Wales, by which 141 men were entombed, points to the urgent necessity for a safe and effective method for the lighting of coal mines and for providing the miners with a really safe lamp. Such a means for lighting can only be attained by electric lamps, and as these can be supplied at a cost but slightly in excess of the charge for the best existing oil lamps, and can be worked to give 10 to 12 hours' good light for about 1d. per lamp per "shift," there is no reason why the electric lighting of mines should not become general. The upcast shaft of a colliery is specially a source of danger; here, a few electric lamps would supply a great want. In the roadways a glow-lamp hung every 20 yards, would afford ample light for the movement of the tram waggons, and the men pushing them, with a small incandescent lamp fixed in their caps, worked by a small battery strapped round their waists, would perform their duties in comfort and safety. For the ordinary miner, an electric lamp, weighing not more than 5 lbs., can be provided, which would also allow him to work not only without risk, but would enable him to double his output, owing to the superior light. Objections have been raised that an electric lamp does not indicate the condition of the air for mines in regard to freedom from, or extent of contamination by, fire damp; but there is now no difficulty in providing the miner with a fire damp detector, safer to use and more trustworthy in its indications than a lamp, and needing little, if any more, skill and experience in its employment.

In addition to affording safety from explosions, the use of electric lamps would guard greatly against the accidents which occur owing to the falls of roofs and sides in mines, as the intense and pure light enables more searching inspections to be made. The importance of such a light is the more apparent when the evidence produced before the "Accidents in Mines Commission," in 1886, showed that for 10 years ending 1880, 39·7 per cent. of the total deaths from accidents of all descriptions in Great Britain were caused by falls of roofs and sides.

We have now to consider the best means for producing the electric light, as although the illumination of the pit bottom, and of the adjacent main road-ways, within a limited area presents no serious difficulties, the possibility of safely extending a system of conductors and lamps to any considerable distance into the interior of mine workings is open to serious question.

The Report of the Royal Commission of Accidents in Mines states:—"The liability to fracture of even very well protected conductors if directly exposed to a fall of coal or stone, and the consequent risk of the production of a spark-discharge at the point of rupture at a time when there is a special possibility of the liberation of gas at the seat of dis-

turbance, constitute a source of danger so serious as to preclude the possibility, with any regard to safety, of applying sufficiently light conductors to be at all manageable in the vicinity of working places, or in any localities where they must inevitably lie exposed, or where they have to be shifted about to different positions, according to local and immediate requirements. It need scarcely be stated, moreover, that the attachment of a glow lamp which is to be used by the miner at his working place, to a conductor which is armoured or otherwise protected to such an extent as to afford prospect of its escaping injury from being trodden on, or from a fall of coal, would render it quite unmanageable, and preclude its being available for providing any useful amount of light close to the face of coal."

The supply of electricity by means of dynamo-electric machines, not being generally practicable for the lighting of coal mines, the illumination can only be supplied by secondary or primary batteries. As regards the former, the results with a well-known secondary battery lamp have not been satisfactory, there being an uncertainty as to the lamps being fully charged when issued to the miners, and serious shortcomings, consequently, in the duration of light have been experienced.

The primary battery appears to be the only practical method of producing a cheap and effective light, and on this point the Royal Commission of 1886 reports as follows :—

"Very decided progress has of late been made in the production of portable electric lamps, giving and maintaining a light superior, at any rate for a considerable number of hours, to that furnished by the best oil safety lamps. It may confidently be expected that efficient lamps, worked by primary batteries, will ere long be available for use in mines at a prime cost not very much greater than that of some of the best forms of safety lamps, and that their maintenance in working order will also not entail very much greater outlay and trouble."

A number of lamps worked by primary batteries have been brought under our notice, but only one has come up to the requirements as to cheapness and duration of light. In some cases it has been impossible to obtain the cost for working owing to the electrolytic fluid used being a so-called "secret" solution, on which a fabulous value has been placed. In other instances the fluid has proved too expensive for practical working, and the battery has been too elaborate and costly, and frequently too heavy and cumbersome.

If colliery proprietors will take the trouble to enquire, they will have little difficulty in providing efficient electric lighting for their mines, and they will thus minimise the heavy losses of life amongst their men, and the disastrous stoppage of output due to accidents. If mine owners are wilfully blind to their own interests, it should become the duty of Government to step in and compel proper precautions.

THE CITY LIGHTING COMPANY.

BEFORE remarking upon the accounts and prospects of the City of London Electric Lighting Company, we should have liked to have heard the Chairman's speech, and if we could conveniently wait until after December 31st next, to which date a much fuller balance-sheet in the form prescribed by the Board of Trade will be made, we should doubtless then be in a better position to criticise. We had, however, to go to press before the speech was delivered, and the end of the year is some way off. We are, as it were, getting up before daylight, and must grope somewhat in the dark.

The whole of the work and expenses, so far, has been charged to capital, except £440 12s. 4d. incurred in connection with issues of shares, the earnings from current sold, meter rentals, transfer fees and dividends on securities being deducted; making the capital expenditure to June 30th £352,752 9s. 1d. net To expect a revenue account before an undertaking is in full swing would be a mistake. It would be impossible to render such an account accurately, and it would be misleading and damaging to the concern. The capital account, as it stands, seems perfectly legitimate, but there are items in it which are inseparable to large undertakings, necessary evils so far as the particular company's shareholders are concerned, although blessings to the members of the promoting companies, to barristers, solicitors and others.

Taking the net expenditure of £352,752 9s. 1d., we find that gross matter and ordinary labour absorb some £260,332, while £92,420 represent the somewhat intangible assets of brain power, rent, taxes, &c. To utilise the labour and material, the company has had to mix them with brains, as the painter his paints, and they appear to have used the vehicle ungrudgingly. As we said before, no doubt it was necessary; but at 5 per cent., it means nearly £3,700 extra to be earned per annum. Of the £92,420, the Pioneer Company got £69,300 for pioneering. The world owes much to pioneers, and does not always requite them so liberally.

It is very satisfactory to notice that up to June 30th, besides the street arc lamps, 11,860 incandescents had been connected up, and applications received for 20,168 more, and that the greater part of the latter will be in operation by the middle of this month. We are also very glad to hear that the consumption of current per lamp installed in City offices, shops, &c., will be much greater than the directors anticipated. We confess to an idea that the City cannot, in respect to consumption of current per lamp, compare favourably with most other well-chosen areas, by reason of its proportional lack of clubs and hotels, and the absence of theatres. The bulk of offices do not use artificial light many hours a-day in winter, and not at all at other seasons.

City shops close comparatively early. Banks, although nominally closing at 4 o'clock, we know are often busy behind their closed doors for hours afterwards; but it is not the whole of the staff which is then employed, so that the full number of lights will not be needed. The basement offices, of which there are many, will doubtless be good, steady customers; fog or shine, they will glow on.

During the hours when the West is most ablaze, the City man has left his office and turned out his lights. There are days, however, when he will turn on every one—when the "London particular" is upon him. We should think that then nearly every lamp installed will be drawing on the central station. Fogs come and go, without warning. It will be necessary to be always ready to give a maximum supply, and that maximum will be very largely in excess of the average daily maximum.

It seems to us that the capital sunk in the City stations, and, to some extent, station expenditure, in proportion to the earnings must be greater than those in other localities, to the detriment of dividends. In the City are a large number of isolated installations; some of these may abandon their plant and have the current "laid on;" but probably not many, as for any considerable number of lamps the price per unit would come under that charged by the company. The City, however, is a compact field. Looking at the cost of mains, in their case, up to the present time—£141,672—we can see the advantage of dealing with large blocks of many-storied buildings, where every room has its occupants, and each occupant may have his lamp. It is much better than a purely residential district. On the whole, the City Company should do well, though some West End companies, and those operating in the centres of large provincial towns, should do better.

Mechanical Pumps for Exhausting Incandescent Lamps.

In the *Electrical Engineer* of New York, there has lately been a discussion as to the relative merits of mechanical *versus* mercurial pumps. In Europe non-mercurial pumps for exhausting incandescent lamps are, we believe, non-existent, and very little has even been published concerning them. It will be interesting therefore to our readers to note a few particulars that Mr. Reinmann gives respecting them and their capacity, in the issue for August 17th. He states that he has used the metallic pump constructed by Messrs. Dittmar and Falkenhausen, which pump was described in our contemporary's issue for June 4th. It is styled the "Electric Air Pump" presumably because the valves are operated by the aid of solenoids. With a cylinder of the dimension 7 × 8 and a stroke of 30 beats per minute, 300 lamps per day may be exhausted so perfectly that a 1-inch spark induction coil only gives faint flashes on the surface of the glass. One result of the rapid stroke is that the removal of the occluded gases may be effected in much less time than is usual, because the incandescence may be raised more rapidly, the gases being removed as rapidly as produced. Fifteen minutes is stated as the time required for the operation. With Geissler pumps, so largely used in America for some unaccountable reason, the pauses between the closing and opening of the valves is necessarily considerable, and all the while the gases keep accumulating when the current is on and tending to injure the filaments. The Sprengel pump is free, however, from this defect. Mr. Reinmann is not able to give actual figures for comparing the respective methods, but he is of opinion that the advantage is in favour of the more recent (and yet older!) method. The principal advantages claimed for mechanical over mercurial pumps may be summed up as follows:—1. More solid construction, and consequently less breakage and repair. 2. Greater economy in power to exhaust a given number of lamps. 3. Increased rapidity of working, and consequent diminished quantity of plant and space. 4. Immunity from unhealthy mercury vapour. 5. Less blackening of the lamps when in use. There is one little consideration in having many lamps on one pump that must not be lost sight of, and this is the possibility of a leaky lamp amongst the number. But, no doubt, the difficulty and delay in seeking the leak could be avoided by arranging the lamps in groups, and devising a leak detector to be fitted to each respective group. The time has not yet arrived for this and other allied matters to need serious consideration in this country, but it is rapidly approaching. When it does come, capitalists will have the advantage of being able to readily secure all the tried and most efficient apparatus and processes used on the Continent and in America, and thus have a very good start.

The Blackening of Incandescent Lamps.

We would call the special attention of those interested in incandescent lamp manufacture to the article on this subject in our other columns. It will be seen that Mr. Cary, the writer of the article, maintains that the blackening of lamps is in a great measure due to the presence of mercury vapour in the bulbs, and the points on which he lays stress go far to support his contention. Should the matter be definitely proved to be true, it will mean that we are on the eve of an important step in advance in lamp manufacture. We do not think with Prof. Thomas that the mercury pump is necessarily likely to become once more a laboratory instrument in the event of definite proof being forthcoming, as we think it quite possible that the alternative course of effectually removing mercury vapour by chemical means may be arrived at; and this possibility will give interesting employment to some of the pioneers who are endeavouring to improve the technical details of the industry. Mr. Cary maintains that the degree of vacuum he is able to reach with the metallic non-mercurial pump is appreciably higher than can be obtained with the customary pump. This may be so; but we do not feel convinced on that point from the method employed to test the vacua, a method which is liable to give very erroneous results due to the inrush of mercury dragging air (adhering to the outside of the glass and pincers used to break off the pip) into the bulb. The induction coil test is probably far more reliable, though this method also cannot be implicitly depended on, as Mr. Crookes has demonstrated. But putting aside the merits of the test, Mr. Cary seems to attribute the extra blackening of mercury exhausted lamps primarily to poorer vacua. It is a question, however, whether slight differences in the degree of vacuum are of such great importance, and whether the entire absence of mercury vapour (which it is conceivable may slowly dissolve the heated carbon more rapidly than other residual gases) is not the material point. Speaking generally, we have not noticed that lamps with comparatively imperfect vacua blacken more readily than others far more perfectly exhausted. It must not be forgotten that however much importance may attach to the presence of mercury, or to the degree of vacuum, that these are not the only causes of blackening, as the nature and treatment of the filament unquestionably also exerts a very powerful influence. Let us hope that this blackening question will receive more attention than it has hitherto done, and that the community will reap material benefit from the labours of the various investigators.

Electric Launches.

Electric launches have now become popular to a certain extent in this country, and in the United States an increasing interest in this class of boat has recently been manifested by the construction of two or three such vessels. On the European continent very little, with the exception of tests on the Lake of Geneva and short runs on the Rhine at the Frankfort Electric Exhibition last year, has been done in this direction. Now, however, an attempt is being made to introduce this type of boat in France, where it may be mentioned an electric launch was first seen in September, 1886, when the *Volta* made the double journey between Dover and Calais. The endeavour in question is being put forth to render the use of this class popular on the Seine, and on the 9th ult., a trial trip on that river took place with the *Eclair*, between Asnières and Epinay. This vessel was described in detail in our "Notes" columns. The trial of the *Eclair* was successful, and from negotiations which are being carried on, it is expected that other electric launches will be introduced in Paris.

THE POSITION AND PROSPECTS OF THE ALUMINIUM INDUSTRY.*

III.

WE have now to deal with the purposes for which aluminium can be used, considering its price, as set forth in the first of these articles, and its properties as described in the second. It has already pretty well occupied the field for the construction of opera and field glasses, and is also coming in for portable telescopes, while for the metal work of photographic cameras and lenses it is replacing brass, and will probably do so entirely in a couple of years. It will also be useful for surveyors' instruments, though when hard wear has to be endured, it may be necessary to bush the working parts with a stronger metal. The cases of portable aneroids, range finders and other kinds of scientific apparatus which have to be carried about, are also advantageously made of aluminium. It is also desirable for certain medical instruments. All these openings, however, although important in themselves, will not absorb a great quantity of metal, and it is to humbler applications that we must look to take the larger proportion of the supply. There is no doubt that for army and expeditionary purposes aluminium will prove valuable. Water bottles are already made of it, culinary utensils will shortly follow; whether it can be used advantageously for cartridge cases is still undecided, but for helmets, scabbards and buttons, it will certainly come in. Portable arc lamps, projectors and field telegraph equipments, will also be constructed of it. How far it may replace the present materials used in electric line construction it is difficult to say, since so little work has been done in drawing wires from the various alloys of aluminium in which the latter metal preponderates. It may be safely said that wires of sufficient tensile strength can be produced, but whether the requisite pliability can be secured at the same time, remains yet to be proved. The makers of bicycles are already alive to the advantages of aluminium, and are commencing to employ it for mud guards, for parts of the brake, and lamps, and some are even trying to utilise aluminium tubes for the frame work. For portable electric light fittings and decorative work there is also a certain opening for the metal, and there are, also, of course, a number of fancy articles for which it will be used, and with which the continental shops are already full. One or two steam launches have been constructed of it, and it may prove useful for light boat building. Household and travelling appliances offer another field for its employment, and a little thought will suggest a good many other articles which could advantageously be made of aluminium, without prolonging this list to a tedious length. From what has been said, however, and from the description already given of the properties of the metal, it will be gathered that at its present price the use of aluminium as a metal *per se*, will rather be in the direction of a number of rather small applications than for one or two purposes of great magnitude, though in the aggregate, the demand will be sufficient to sustain a respectable industry. Some may be disappointed at the limited field for aluminium which is here set forth, but there has been so much that is wild and erratic said on the subject, that we have been careful here to confine our predictions to the region of immediate practicability, and to mention only uses to which aluminium can clearly be applied with advantage, taking into account its price, properties, and our present knowledge of the manner in which it can be worked.

We will now turn to the use of aluminium as a metal for alloying; this is the direction in which more than 50 per cent. of the present output is utilised, and it is one which will certainly increase greatly both in magnitude and importance.

Everyone is more or less aware that the alloys of aluminium and copper or aluminium bronzes have valuable properties, but beyond this, it is astonishing how little exact knowledge there is on the subject, though this may be accounted for by the fact that until quite recently the cost of aluminium has been too great to permit of its use for anything except very special purposes.

When aluminium and copper are brought together at or near the melting point of the latter, they combine with the evolution of sufficient heat to raise the temperature of the mass to a high degree, at the same time a shrinkage occurs, so that the resulting alloy is from 2 per cent. to 4 per cent. less in bulk and correspondingly denser than mere calculation from its constituents could lead us to anticipate.

These alloys are readily formed by holding ingots of aluminium under the surface of molten copper. At first, the copper is chilled, but as soon as the aluminium is heated to its melting point (a low red heat), combination occurs and the temperature is raised to a brilliant white heat, no fumes are given off, and the working of the aluminium bronzes is therefore a far healthier process than that of making brass. As soon as fusion is complete, the alloy should, if required very homogeneous, be poured into ingot moulds and allowed to set, and then be remelted. When once the constituents are thoroughly blended, there is no tendency for the metals to separate, and a perfect alloy is formed; but it is not advisable to keep it standing melted in crucibles longer than is necessary, as it is liable to be deteriorated thereby.

In this way a set of bronzes can be formed, varying in their properties according as the proportion of aluminium is greater. About 2 per cent. is the smallest useful addition to produce a marked result, and the effects are increased up to 11 per cent. This latter quantity of aluminium produces an extremely strong and tough metal, having a breaking strain of from 40 to 45 tons per square inch, a hardness nearly equal to steel, but which, with proper precautions, can still be forged and rolled, while in the lathe it cuts smoothly and cleanly, and is eminently adapted for the production of work requiring precision and accuracy. When it is remembered that the breaking strain of ordinary brass is under 14 tons per square inch, while gun-metal averages 16 to 17 tons per square inch, the great value of aluminium bronze becomes apparent. Its qualities are also superior to the numerous alloys which have been brought out within the last few years, with the object of supplying a material of greater strength and wearing power than ordinary bronze.

When the aluminium bronzes were first introduced commercially by the Cowles Company, much attention was drawn to them; but for various reasons, the interest has not been maintained as it might have been. This was probably partly due to the fact that the cost was still too high, and also because their alloys always contained a considerable quantity of silicon and iron, which rendered them harder and less workable than they would otherwise have been. Now, however, that aluminium of over 99 per cent. purity is obtainable at such a reasonable rate, and that alloys can readily be manufactured of great purity, they are well worthy of the serious attention of engineers, and must, for hydraulic work, for high speed engines, for dynamos, and for bearings wherever the wear is excessive, and many other purposes, prove of great value. It is unfortunate in some ways that these alloys are free to everyone, because it being nobody's business to look after them specially, it takes a long time to obtain reliable data of their behaviour in practice. We believe, however, that the Lancashire and Yorkshire, and the London and North Western Railway Companies are testing them on a considerable scale, and as they are coming into use extensively on the Continent and in America, we may hope before long to be in the possession of more precise comparative particulars of their working than can be obtained at present.

Besides the aluminium bronzes, the alloys of aluminium with brass are most important. By the addition of about 2 per cent. of aluminium to ordinary brass, the breaking strain of the metal is increased to nearly double, and its toughness and power of resisting shearing stress are also much improved. This should be one of the most popular aluminium alloys, since it is so easily and cheaply made; there is nothing to be done but to add the requisite quantity of aluminium to the brass as soon as it is melted, and stir the mixture well, or if the brass is being made at the time the aluminium should be added first, and before the zinc, as its melting point is the higher of the two, and it is not volatile as zinc is. Even this small amount of aluminium lightens the colour of the brass considerably. As a simple and certain method of producing a very strong metal, the addition of aluminium to brass can hardly be surpassed, and when it has been once tried will, we feel confident, establish itself on a permanent footing. The additional cost of treating brass this way is only about 10 per cent., which, in comparison with the advantages gained, is a mere trifle.

* The previous articles on this subject appeared on July 15 and Aug. 19.

Of the value of the alloys of aluminium and iron and steel, it is not possible, so far, to speak with quite the same confidence as is justified in the case of the bronzes; but this is more owing to commercial than to physical reasons. To add the requisite quantity of aluminium to copper or brass, is to increase the price of the metal obtained only in a moderate degree; but to add 2 per cent. or 3 per cent. of aluminium to iron or steel means doubling or trebling its cost in the ordinary way, and consequently, although improved qualities may be obtained in some respects, it is doubtful if in most instances the cost at which they are purchased is not, except for a few special purposes, too great to admit of the alloys being used on a large scale. But for fine steel castings, and for delicate work in iron, the addition of small quantities of aluminium is justified thoroughly. About $\frac{1}{4}$ per cent. of aluminium added to steel or iron appears to combine with occluded gases, and dissolved oxide which it brings to the surface, rendering the metal homogeneous and capable of producing sounder castings, while at the same time its fluidity is increased, and its power of taking a delicate impression in a mould is improved. As metal can be treated in this way for about 30s. per ton, the additional cost is not of much moment in comparison with the advantages obtained, and the matter is well worth the attention of manufacturers.

Aluminium has been successfully added to type metal and to the German silver alloys. Two or three per cent. has also been found an advantage in the galvanising bath, which we can quite understand, though an alloy of this kind needs careful watching in after use, as alloys have a tendency to be more acted upon by the weather than pure metals, no doubt from the greater tendency to set up electrolytic action.

In conclusion, it has been the object of these articles to set the position and prospects of the aluminium industry in a fair light, and to enable a correct judgment to be formed of its position and prospects, and this is desirable, because while on the one hand the metal has been unduly extolled by enthusiastic advocates, on the other hand a natural reaction has caused its undoubtedly valuable properties to be under-estimated. From what has been said, however, it is clear that at the present price of about 2s. 6d. per lb., there is, or will be, room, for a very considerable output as soon as manufacturers and engineers are generally acquainted with its use. This will lead to the establishment of larger works, when the cost of manufacture will be considerably reduced, as was explained in the first of these articles, and will enable the market price to be further lowered. Room still remains for a great deal of work and experiment, and much of what has been done needs properly digesting, but the industry has now been set fairly on its legs, and these will follow in due course. There is one point concerning which those who are interested in aluminium will do well to take heed, and that is, to place but little reliance on data which were published more than a few years ago, unless confirmed by something recent, as early experiments were conducted on too small a scale and with impure metal.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

WE reported,* somewhat fully, at the time of their delivery, the Cantor Lectures delivered by Prof. George Forbes on this subject. The first and second lectures are now given in full in the *Journal of the Society of Arts*, the first dealing chiefly with the distribution of electrical energy from central stations by means of low pressure currents. The difficulties met with in low pressure distribution are plainly set forth. The fall in pressure in the distributing mains—one of the most serious drawbacks—is treated at great length, and the remedy, in the shape of main feeders, is clearly described. This main feeder question is one about which there is as yet no definite rule or data to enable engineers to calculate their weight and dimensions; in fact, there is a great diversity of opinion as to the application of feeders in practice. Whether the copper is put down in the form of distributing mains of heavy section without feeders, or in the form of distributing mains of half the section, placing one half of the copper as mains, and the other half as feeders, the weight of copper is enormously great in any system designed to work with economy and constancy of pressure. It is stated in the lecture that about one-half of all the capital expended on a low pressure distribution scheme should be spent on the mains for distributing the electricity. This necessity for sinking such a large amount of money in copper has undoubtedly been one of the chief causes for the backward state of electrical distribution in towns. The lecturer expressed his satisfaction with the progress made with low pressure distribution, even in the face of the large outlay in copper required; but it must be borne in mind that the success is not due to any merits in the system; it is entirely due to the fancy price obtained for the electricity, so long as 8d., 10d. and 1s. per unit can be obtained; then low-pressure distribution, pure and simple, may be made to pay. Low-pressure distribution seems to be quite fashionable just at present among advising engineers called in by local authorities to assist in establishing electricity supplies. These gentlemen seem to feel safe in this field, and the question of cost does not seem to be one worth mentioning, neither is the question of future extensions considered; only in too many cases the advice amounts to simply this: "Put down a set of steam dynamos made by so-and-so, run out a three-wire system of mains, plenty of copper; inside of the compulsory area there is no need for any devices to save copper, nor for the maintenance of constant pressure."

The lecturer says that 10 years' practice in central station working "has stereotyped our practice a good deal." It would be nearer the mark to say that 10 years' practice with low-pressure distribution proves that it can never be expected to distribute electricity on that scheme, at any price under the high one now charged. The practice in that system of distribution is certainly stereotyped, the reason being that there is no room for improvement; the system cannot be modified in any way to make it better.

The five-wire system is really an attempt to combine the advantages of high-pressure distribution together with the advantages of low-pressure, and it is a debatable question whether a simple two or three-wire high-pressure system is not really preferable. A low-pressure distribution system with feeders to maintain a constant pressure, such as sketched by Prof. Forbes for Philadelphia, is, in fact, a sub-station system in which there is a transmission system of mains—called feeders—and a system of distribution mains; the points to which the feeders are attached to the distributors may be taken as sub-stations—the simplest of all sub-stations. In such a scheme, the advantages which would be secured by the use of high-pressure for the transmission along the feeders is very obvious; the only additional plant required being a transformer at each sub-station.

Prof. Forbes's own device for regulating the pressure in the feeders of a low-pressure supply is a very effective and clever plan. He puts one of his non-polar commutatorless dynamos in series with the feeders; this dynamo then adds or subtracts a few volts as required for regulation.

On the matter of the high price of electricity, the lecturer rightly fixes the chief reason for the high prices on the idleness of the whole plant for the greater part of the 24 hours; there is here felt the absolute necessity for storage; whether one system or another is adopted for supply, the want of storage must add largely to the cost of supply, and there can be no doubt it would be worth paying a good deal for storage on a large scale.

The high price of electricity makes its use prohibitive for many purposes, motive power among others, hence there is no demand for it during the day. There can be no doubt that a cheap supply would be much more drawn upon during the day, so that the load line would not be for so many hours below zero.

There is one direction in which we may look for improvement in central station practice, and that is in the use of gas engines in place of steam engines for driving the dynamos. A great part of the losses in existing stations is due to the sudden demands for large supplies lasting only a few hours in the evening. To meet these sudden demands boilers have to be fired up, and steam made ready for an hour or two beforehand; then all the fire and steam in the boilers, when the demand falls off, is generally frittered away—allowed to die out.

Gas engines have these advantages: they can be started instantly—all consumption ends when the engine stops. Gas can be stored without loss. Steam cannot be kept up with-

* January 29th, 1892, and three following issues.

out constant expenditure. It would be therefore very interesting and valuable to have a comparison made between the cost of working a 100 horse-power gas engine and a 100 horse-power steam engine.

Hitherto, gas engines have been small powers mostly, and their design, usually of the horizontal type, occupying much space and requiring heavy foundations. It does seem curious that hitherto the principal gas engine makers should all build their engines on almost the same patterns, single acting, horizontal, overhanging cylinder, and all the rest. It would seem to the ordinary engineering mind that a gas engine, being a single-acting engine, whose bearings are all, or rather ought to be, in constant thrust, ought to be upright, vertical, with inverted cylinders ; such a design would run at higher speeds without vibration, and would occupy the least floor space. Large powers would be required, but there does not seem to be any difficulty about that.

At central stations using gas engines, the starting up of a number of engines for a short run would not cost one-half as much as it does to start up a similar lot of steam engines, and when stopped no further loss goes on with a gas engine.

No doubt, as the lecturer remarks, some good solid work has been done with low pressure distribution systems, but we cannot admit that the work is on any very large scale. The low-pressure systems which have shown good solid work are very few and very favourably situated, being planted right in the centre of wealthy districts of small compact dimensions. The objections first raised against low-pressure distribution have never been overcome, and its present apparent popularity in some quarters seems to be entirely due to the ignorance of the authorities in whose hands lay the choice of a system. These authorities have a small compulsory area to deal with only in the meantime, and as such an area is usually quite within the range of a low-pressure supply, low-pressure distribution is adopted, being considered as a well-tried simple system. The price fixed for the supply is usually large enough to cover the excessive cost of such a system. When the supply is laid on, customers who can afford the luxury adopt the light, but meanwhile very little general movement in favour of electricity is made ; the general opinion is strengthened to the effect that electricity is too dear yet for general adoption.

With the lecturer we hope "it will be found that there are engineering resources at our call which have yet to be invoked before we have reached the final solution of the problems."

THE CURRENT THAT CURES.

By H. NEWMAN LAWRENCE, M.I.E.E.

II.

(Continued from page 263.)

SEVERAL forms of current may be employed upon the body with advantage. Each form possesses physical and physiological properties of its own, and is, therefore, capable of producing a separate effect upon the human organism. The lines of demarcation are not always clear, owing, most probably, to the present elementary state of our knowledge of the whole subject ; but I look forward to the time when the physical and physiological effect of a certain quantity of each form of current shall be definitely known. The forms of current most used are (*a*) the continuous, (*b*) the interrupted, (*c*) the alternating. Of these, (*a*) the continuous is generally obtained from a galvanic battery, and hence has received the name of galvanic or voltaic. These names, however, belong rather to the past than the present, for they seem to imply that the galvanic generators produce electricity essentially different from that obtained from other generators. Now that dynamo-generated currents are laid on to our houses to give us light, and have been proved to possess the same physical and physiological properties as the galvanic generators, there is no reason why these misleading terms should be longer used. Electricity is one and the same, however generated. A continuous current is one which flows steadily in the same direction throughout the circuit, and is a continuous current, be its source of generation a galvanic battery, a dynamo, or a thermopile. Such a current is mainly of use to the body, by reason of its chemical property, whereby it aids and accelerates the physiologico-chemical processes when employed medically, or produces local decomposition when used surgically. As this chemical property is directly proportional to the quantity of current that flows, it is manifestly necessary to measure it. The unit of current adopted by electricians generally, viz., the ampère, is far too large for medical purposes, so its thousandth part, or the milliampère, is taken as the practical unit in electro-therapeutics. It follows, therefore, that a dose of continuous current may be defined as n milliampères passed for n' minutes.

The next two forms of current (*b*) and (*c*) are often regarded as one and the same thing ; in fact, very few of the medical works attempt to differentiate between them. They are spoken of indiscriminately or collectively as the Faradic current, though there is considerable difference in their therapeutic effect. This confusion has probably arisen on account of the fact that each possesses to a marked degree the property of contracting muscle, and, as in the rough-and-tumble applications so much in vogue till quite recently in cases of paralysis, muscular contraction was the only effect aimed at, the finer and more subtle actions of these forms of current were overlooked. Another reason for this lack of discrimination is to be found in the means adopted for the supply of such currents. The induction coil was till quite recently the only available apparatus for producing both the interrupted and the alternating currents. Some makers of coils supplied terminals by which the secondary or alternating current only could be used, while others arranged for tapping the primary or interrupted also, and medical men and nurses were left to regard a coil battery as a muscle-contracting machine only, with (generally) a weak effect from the primary, and a stronger effect from the secondary.

The interrupted current I take to mean that which passes through the primary wire of an induction coil, interrupted by the vibrating contact breaker, but still flowing in one direction, and having superimposed upon it the self-induction of its own circuit, and the magnetic induction of its core when (as is usually the case) a soft iron core is present. Such a current possesses a far greater E.M.F. than it would if proceeding direct from the battery without interruption, though, of course, its current strength is proportionally reduced. It is, however, still largely of the nature of continuous current, for it flows in one direction, and possesses, though in a lower degree, the chemical and magnetic properties of that current. It is thus useful as a sort of connecting link between the continuous and the alternating, possessing, as it does, some of the chemical property of the former and some of the muscle-contracting power of the latter.

Alternating current as obtained from the secondary wire of induction coils has long been recognised as a valuable therapeutic agent. Such alternating current is also interrupted, as the alternations depend upon the interruptions of contact by the vibrating arrangement. The current of alternating dynamos is now receiving attention, and appears to possess advantages in the treatment of certain nervous conditions by reason of the regularity and smoothness of its alternations, which coil currents can hardly possess.

Some writers, in dealing with coil currents and their action upon the body, have endeavoured to set up special theories to account for apparently difficult phenomena, by supposing that certain currents possess *elective* qualities, or certain organs have special affinities for some currents while they reject the advances of others. Such theories may be very pretty and perhaps ingenious, but they partake somewhat of the nature of quack statements, and lend themselves readily to the deception of the unwary. They certainly should not be adopted, or even suggested, till all the known laws by which electric currents and their effects are controlled have been proved and found wanting. Costly and complicated coils have been constructed and dilated upon at length by some who take delight in these theories, but, so far as I can see, there is no gain, but rather loss by their use.

Coil currents influence the body by their current strength and their rate of interruption or alternation, and provided these factors have the same value (which, of course, implies that there is sufficient E.M.F. to overcome the resistance in the circuit), the effect will be the same no matter what the size or construction of the coil. There is no need to look further for an explanation of each and all the phenomena

which accompany the application of coil currents. Measurement is again the essential item, and when this is given its due attention, all elective and similar theories become not only useless, but absurd.

Unfortunately, the difficulties of measuring the quantity and rate of vibration of coil currents is great, but that is no reason why we should not endeavour to attain accuracy as far as may be. In this form of the current that cures, even the milliampère is too large a unit. Owing to the interruptions, the effect of these currents upon the sensory nerves is such that a very small quantity produces considerable pain, and few persons can bear even 1 milliampère. A smaller unit must, therefore, be adopted. Further, instruments capable of measuring such small quantities of alternating current are difficult to obtain, costly, and far from portable.

Something, however, might be done if coils were to be made with a definite efficiency, and wound with a regular ratio between the E.M.Fs. of the primary and the secondary, then by measuring the electrical energy put into the primary, we should be in possession of a fair approximation of that given out by the secondary, and of how the voltage and the ampèrage is apportioned.

The rate of vibration has, as yet, received little attention, but the rage for investigation with currents rapidly alternating which has followed Mr. Tesla's experiments has even penetrated the sluggish regions of electro-therapeutics, so that better and more convenient methods of measuring the rate of vibration may soon be looked for. The importance of this measurement can hardly be exaggerated, owing to the influence the rate of vibration has upon the sensory nerves.

How far the effects of static electricity deserve a separate heading in this article it is difficult to say, but in the light of the researches of Lodge and Crookes, in England, of Helmholtz in Germany, and of Tesla in America, there can be little objection to considering them under the head of alternating currents. For my own part, after considerable observation and experiment, I consider the effect on the body of high potential alternating currents from coils or transformers may be identical with that of the oscillatory discharges of static and influence machines, provided the alternations of the former be sufficiently rapid, and due attention be paid to the strength (perhaps I ought to say the weakness) of the current and the rate of alternation at the moment of discharge.

(To be continued.)

WATER POWER.

BY E. TREMLETT CARTER.

(*Continued from page* 255).

13. *The Hydro-dynamic Equation.*—An important equation affecting the flow of water in closed or open conduits, and one directly deduced from the principle of the conservation of energy, is that which is generally known as the *hydro-dynamic equation*. We have already seen that a mass of water at a given height possesses potential energy; and we know that it can lose none of this energy unless it does work, and that the extent to which it loses energy is measured by the extent to which it does work. Now, when the mass of water falls from the given height to a lower height, without doing work of any kind, its *potential* energy as such is yet reduced, so that some of its original potential energy must have been converted into energy of another form during the fall. There is one possible other form, which we have already discussed, viz., kinetic energy, or the energy of motion; but it is not at all necessary that the water shall have acquired an amount of this second form equal to the loss of the first. For we may make the kinetic energy anything we please, between zero and the maximum velocity, by regulating the section or flow of the water. Obviously, there must be a third form of energy into which the lost potential energy may be converted, and this is found to be the energy of pressure. Lest there should be some misunderstanding, it should be said that pressure itself is not energy, but is one of the factors of this third form of energy—the flow being the other factor. The original head, H, may, therefore, be split up into four components, at any point in the system of conduits; (1) a head due to the new position of the water, (2) a head due to the velocity of the water, (3) a head due to the pressure of the water on the sides of the conduit, (4) a head due to energy expended usefully or against friction during the change of place of the water. At every point in a hydro-dynamic system the sum of these four heads will be a constant, and equal to the total original head at the source. In fig. 10, at the top of the reservoir any water particle would

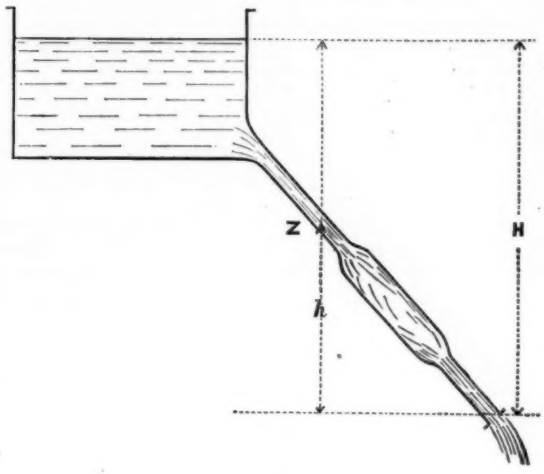


FIG. 10.

have a head, H, due to height alone; but at any point, Z, lower down in the system of conduits, where it has a velocity, v feet per second, and exerts a pressure, P lbs. per square foot, its head would be—

$$H = h + \frac{v^2}{2g} + \frac{P}{62{\cdot}4} + \frac{W}{Q} = \text{a constant.}$$

Where W is the work done by any quantity, Q, in falling from the original height, H, to the new height, h. The above is the hydro-dynamic equation, and several important deductions can, and will now, be made from it.

If the end of the pipe is quite closed, the velocity, friction and work done must each be equal to zero.

Then,

$$H = \frac{P}{62{\cdot}4} + h,$$

or,

$$P = 62{\cdot}4\,(H - h).$$

This gives the pressure per square foot at any point *when the water is not in motion.*

If the water is in motion, and no work is done, then, neglecting losses due to friction,

$$H = h + \frac{v^2}{2g} + \frac{P}{62{\cdot}4},$$

whence,

$$P = 62{\cdot}4 \left\{ (H - h) - \frac{v^2}{2g} \right\}.$$

Or, the pressure when the water is in motion is equal to the pressure due to the difference between the total head at the place, and the head due to the velocity. This pressure is, of course, the effective pressure, or the difference between the internal and external (atmospheric) pressures. The lowest value for this quantity, P, is, therefore, the equal and opposite of the pressure of the atmosphere. (Call this latter P_a lbs. per square foot). In other words, if the back pressure of the atmosphere is not removed the minimum value of P is simply zero, while if it *is* removed, the minimum value is equal and opposite to P_a. For no liquid can be placed under a really negative pressure, and the attempt to do so results in the column of liquid splitting up into detached masses with vacuous interspaces. If then, the atmospheric pressure is not taken from the bottom of the head, the velocity of the water is—

$$v\ (\text{max.}) = \sqrt{2gH}$$

While, if it is removed, the pressure becomes,

$$62{\cdot}4 \left\{ (\text{H} - h) - \frac{v^2}{2\,g} \right\} = - \text{P}_a$$

And the velocity,

$$v\ (\text{max.}) = \sqrt{2\,g \left(\text{H} + \frac{\text{P}_a}{62{\cdot}4} \right)}$$

This is the maximum possible velocity which can be produced at any point, H feet below the level of the water supply; and this only when special means are taken to remove the pressure of the air. In open conduits the surface pressure of the water is everywhere equal to the atmospheric pressure, so that the maximum velocity is given by the first of the two equations. In an open conduit system, "head due to pressure" cannot exist, the changes of velocity in different parts of the conduit being accompanied by alterations of level or height. Thus, in a bend in a stream, the velocity at the outer edge of the bend is less than the velocity at the inner edge, while the level of the water at the former place is higher than at the latter.

The last application of this law or general equation which we shall make relates to the free flow of water in a vertical or inclined conduit, of uniform section. In fig. 11, water is

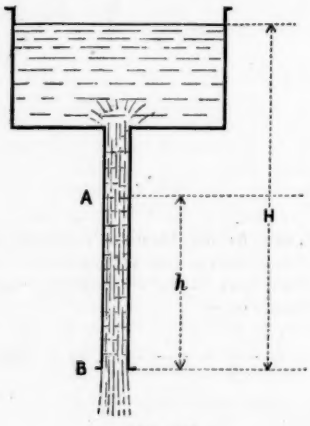


FIG. 11.

permitted freely to escape from the orifice at B, at a distance H feet below the surface of the source; and the velocity with which it does so is,

$$v = \sqrt{2\,g\,\text{H}}$$

Assuming that the conditions are such that the water flows in an united mass through the pipe, and remembering that the section is the same at all parts, we find that the velocity is the same at all levels. Now, the head at any point A is,

$$\text{H} = \frac{v^2}{2\,g} + \frac{\text{P}}{62{\cdot}4} + h.$$

And,

$$\frac{v^2}{2\,g} = \text{H}.$$

Therefore,

$$\text{P} = - 62{\cdot}4\,h.$$

The effective pressure at any point h feet above the orifice, is of negative value when the water flows freely from the orifice, *i.e.*, it is less than the atmospheric pressure. But, as we have seen, it can never be really negative; that is to say, its lowest possible value is equal and opposite to the value of the atmospheric pressure at that place and time. Thus,

$$\text{P (min.)} = - \text{P}_a = - 62{\cdot}4\,h \text{ max.}$$

And,

$$h\ (\text{max.}) = \frac{\text{P}_a}{62{\cdot}4}$$

At this height above the orifice, when the flow is under the conditions specified, the pressure is reduced to the absolute zero. Taking the normal value of the atmospheric pressure, at sea level, we find that the maximum value of h is about 33¼ feet. If the pipe is lengthened beyond this the water splits up into detached masses with vacuous interspaces.

We here possess a means of removing the atmospheric back pressure from any point in a closed conduit, and thus of increasing the velocity to the maximum theoretical amount. A vertical or inclined pipe, called a *suction pipe*, with a vertical fall not exceeding 33¼ feet, and open at the end to its fullest extent, will cause the desired reduction of pressure at its upper end. It therefore appears that an engine may be placed at any point above the bottom of the fall not exceeding 33¼ feet above that point, and the velocity of the water entering the engine shall be not less than when the engine is placed at the very bottom of the fall. On a fall of 100 feet, for instance, we may place the engine at the very lowest point—in the tail water—or we may place it anywhere within about 30 feet from the bottom, without loss of head or alteration in the efficiency of the system. In practice 33¼ feet is too high a limit to the fall of the suction pipe, and for the following reasons:—It is impossible to obtain perfectly airtight joints to the pipes and the junction with the engine, so that the vacuum is injured on that account; next, the barometer cannot be relied on to keep at standard pressure (or if the barometer does, the air will not); and, lastly, the mill site is often some distance from the sea level.

14. *Constricted Efflux.*—In the previous section the conditions of free flow from an orifice have been discussed, it now remains to consider the effect of reducing the area of the orifice below the sectional area of the stream. There are three points of importance in this connection: the velocity of efflux, the section of the jet, and the frictional resistance of the orifice. If we consider a water particle just after it has left the orifice, we find that it is free from any constraining pressure, and that it cannot, therefore, exert any pressure itself; whence its head is entirely due to position and velocity, and if it has done no work, will be equal to the original head, H, thus

$$\text{H} = h + \frac{v^2}{2\,g}$$

Whence the water issues from the jet with a velocity which is independent of the size of the orifice, for all sizes not exceeding the sectional area of the conduit. In practice, however, the frictional resistance of the orifice will alter this result, leading the water to issue at a lower velocity when the passage is smaller. If by H is meant the effective head outside the orifice, then the velocity is equal to that which a free water particle would have if it fell in vacuum a vertical distance equal to this head. Thus, suppose the total head to be 100 feet, and that through friction in the pipes and the orifice 10 feet of this is lost, the water will issue with the same velocity as any object would have if it fell in vacuum a vertical distance of 90 feet.

Considering next the section of the jet at the point where it has this velocity, we find that it is not in general equal to the area of the orifice but is less than this. Contraction of the jet below the full area of the orifice takes place with almost every shape and size of orifice, and the ratio of the section of the jet to the area of the orifice is called the *coefficient of contraction of the jet*. The value of this constant depends on the shape of the jet and the effective head under which it is produced. Obviously the best orifice will be that in which the value of this coefficient approaches most nearly to unity. It is found that by well rounding off

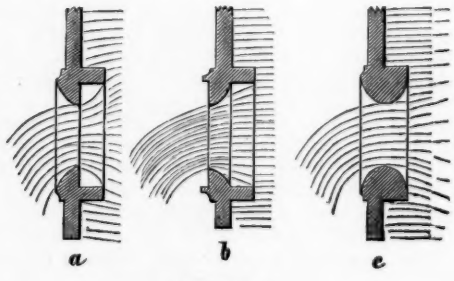


FIG. 12.

the edge of the orifice, both on the in-flowing and the out-flowing sides, the coefficient is increased, which seems to indicate that this contraction is due to eddying set up by the check which is given to the stream on altering its velocity of flow. The coefficient is unity only for the "vena contracta" or *contracted vein*, a conical mouthpiece in which, if d is the diameter at the point of entry of the water, then the diameter at a distance $\frac{1}{2}d$ is equal to 0·7854 d. Space does not permit of our entering very fully

into this subject, which is, nevertheless, of some importance to hydraulic engineers and users of water power; and we can only consider one example of the effect of head and of the shape of the orifice upon the contraction of the jet. Some valuable observations have been made by Mr. J. F. Bateman on the contraction of water issuing through submerged sluice boards. Three shapes of sluice were tried, and are shown in section in fig. 12, the results of the tests being given in the following table. The length of the sluice orifice, across the stream, was in each case 6 feet, and the opening had a depth of 6 inches. The radius of the quadrantal edges was 2½ inches, and the head was measured to the centre of the orifice.

Head in feet.	Values of the coefficient of contraction.		
	(*a*)	(*b*)	(*c*)
4·0	0·723	0·880	0·950
3·5	0·708	0·880	0·950
3·0	0·708	0·880	0·950
2·5	0·700	0·880	0·960
2·0	0·700	0·880	0·960
1·5	0·690	0·880	0·965
1·0	0·700	0·861	0·911
0·5	0·662	0·750	0·820

This table shows that the rounding of the edges results in a freer flow of water; and that, except in the case of very low heads, the contraction is the same for all heads, diminishing only when the head is very much reduced.

From the section and velocity of the water issuing from the orifice, the quantity of flow can be estimated. The flow in cubic feet per second is,

$$Q = c \,.\, A \,.\, v = A \cdot c \sqrt{2\,g\,H}.$$

Where H is the effective head outside the orifice, measured with respect to the level of the orifice; and A is the area of the orifice.

Loss of head occurs wherever flowing water passes through a suddenly contracting passage, as at a sluice or throttle valve; and the extent of the loss is proportional to the rapidity with which the section is changed, and the ratio of the change. The energy expended on account of this loss is developed in the form of heat in the agitated water. Rankine gives the following expressions,

$$\text{Loss of head due to hole in thin plate} = 0{\cdot}054\ \frac{v^2}{2\,g},$$

$$\text{Loss of head due to a T-joint in pipes} = 0{\cdot}0505 \cdot \frac{v^2}{2\,g},$$

Loss of head due to sudden throttling in a conduit of uniform section, the stream expanding again to its original section,

$$\left(\frac{A}{c\,.\,a} - 1\right)^2 \cdot \frac{v^2}{2\,g}$$

Where A is the section of the pipe, and a is the amount of opening of the throttle valve; v being the velocity in the pipe. The coefficient c is equal to

$$c = \frac{0{\cdot}618}{\sqrt{1 - 0{\cdot}618\left(\frac{a}{A}\right)^2}},$$

It will readily be learned from a few well-chosen numerical examples, which the reader might work out, or which will be given in a later section, that the design of valves and sluices for regulating the flow of water to the engine is a matter of considerable economic importance. In the next section some examples of these engine details, and a few rules for designing them will be given.

(To be continued.)

THE SIEMENS ELECTROLYTIC PROCESS OF EXTRACTING COPPER FROM ORES.

THE electrolytic extraction of copper from its ores, as hitherto carried out, has involved the use of impure copper or copper matte as anodes, from which the metal was dissolved and then deposited galvanically at the cathode. In this process, however, only a part of the current is utilised for dissolving the copper, and the solution soon becomes poor, requiring replacement with fresh solution, the formation of which from the ores is attended with trouble and expense. Moreover, the use of copper matte for the anodes requires a previous smelting of the roasted ore, and the plates, when once cast, interfere with the process by falling to pieces before they are completely dissolved. Soluble anodes are, however, necessary in the ordinary electrolytic process, because the use of insoluble anodes leads to strong polarisation, which, of course, greatly reduces the efficiency of the current.

In the "Siemens process" of extracting copper from ores, which has now been in continuous operation at Martini, Kenifelda-Berlin, since June, 1890, the chief difficulty attending the electrolytic method of extracting copper has been overcome by adding to the decomposing copper-carrying solution another solution, which takes up the oxygen set free at the insoluble anode and succeeds in lessening the polarisation.

For the deoxidising solution, ferrous sulphate is employed. This substance is changed by the oxygen set free at the anode into ferric sulphate. In this way a lixiviant for the copper contained in the ore is obtained, for ferric sulphate will dissolve metallic copper as well as the sulphides of this metal. Instead of the iron sulphates, the chlorides, ferrous and ferric, were formerly used with similar results, but abandoned on account of the practical difficulties with which their employment was accompanied.

Dr. Höpfner's method differs from that of Siemens's, inasmuch as the chlorides of copper are employed instead of iron salts. It is also worked by a different form of apparatus.

The electrolyte in the "Siemens process" consists of a mixture of ferrous and cupric sulphate solutions, to which is added a little free sulphuric acid to increase the conductivity. The liquor is continuously supplied to the cathode chamber, where a portion of the copper is deposited by the electric current, after which, the liquid passes down into the anode chamber and is finally drawn off at the bottom.

During the downward passage the ferrous sulphate is changed into basic ferric sulphate, by the action of the free sulphuric acid which is produced by the decomposition of the cupric sulphate, which, by reason of its superior gravity sinks to the carbon rods or plates which compose the anode.

The liquor drawn off from the bottom of the anode chamber is poor in copper, and consists for the most part of neutral ferric sulphate. This solution has the property of converting the cuprous and cupric sulphides as well as the metallic copper into cupric sulphate; thus the ferric sulphate is reconverted into ferrous sulphate, while the oxygen set free oxidises the copper.

Dr. W. Borchers in his "Electro-Metallurgie" (1891), gives the following re-actions as taking place during the process.

$$x\ H_2SO_4 + 2\ CuSO_4 + 4\ FeSO_4 = 2\ Cu + 2\ Fe_2(SO_4)_3 + x\ H_2SO_4.$$

$$x\ H_2SO_4 + Cu_2S + 2\ Fe_2(SO_4)_3 = 2\ CuSO_4 + 4\ FeSO_4 + S + x\ H_2SO_4.$$

$$CuO + H_2SO_4 = CuSO_4 + H_2O.$$

$$3\ CuO + Fe_2(SO_4)_3 = 3\ CuSO_4 + Fe_2O_3.$$

$$CuO + 2\ FeSO_4 + H_2O = CuSO_4 + (Fe_2O_3 + SO_3) + H_2.$$

The oxidation and solution of the copper can be completely carried out with many finely pulverised sulphide ores, even in an unroasted condition, by the use of a moderately heated solution. With other ores, however, a moderate roasting of the "pulp," by which the copper compounds are converted essentially into cuprous sulphide, must precede the solution of the copper.

The lixiviation of the pulverised ore by means of the "decopperised" and deoxidised liquor is performed in troughs, the "pulp" being kept in suspension by means of mechanical stirrers.

The liquor coming from the electric cells is continually fed into the head of the trough, mixed with the necessary amount of "pulp," and it leaves the trough with the "decopperised pulp" at the other end, the solution being hastened by the application of heat, which is supplied by steam pipes in the bottom of the trough. The "pulp" is separated from the solution either by a settling or filter pump; it is now rich in copper and is deoxydised, and is therefore ready to be fed anew into the electrical apparatus.

The process, as will be seen from this description, is con-

tinuous between the "leaching" of the ores and the electrolysis of the solution, the lixiviant being produced electrically in the decomposition cells and the electrolyte regenerated chemically by the solution of the copper in the ores.

The time required for the completion of the process is about two hours, and the amount of copper remaining in the residues is from 0·1 to 0·5 per cent. whether the ore is rich or poor in metal.

Our information is drawn from the *Engineering and Mining Journal*, where fuller details are given than are to be found here, together with some fine illustrations, which show the arrangement of the plant.

ELECTRIC PERCUSSION DRILLS.

MR. HARRY N. MARVIN recently read before the American Institute of Electrical Engineers an elaborate paper on the theory and practice of the electric percussion drill, illustrated the subject by admirable diagrams and sketches, and instanced cases from his practical experience of the working in various kinds of stone. But the matter has been discussed several times of late, so that it will not interest our readers to reproduce the text of the paper. However, there are points of special importance raised by Mr. Marvin, and since he conceives that the fundamental objections to the use of solenoidal drills are now overcome, we describe one of the latest machines.

Fig. 1 is a sectional view of the drill, which outwardly closely resembles the well-known compressed air machines.

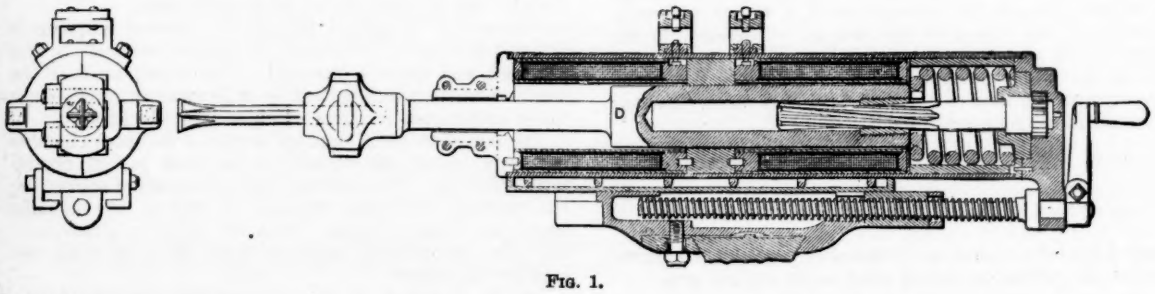


FIG. 1.

The bit shaft, D, is a solid steel forging four inches in diameter, being reduced in section where it passes through the front end. The ratchet device is similar to the rotating gear in a compressed air drill. The bit will make about 380 blows per minute, with a travel of from $6\frac{1}{2}$ to $7\frac{1}{2}$ inches. The plunger weighs 80 lbs. The "buffing" spring used on the in-stroke is of the volute form, and the feed is adjusted by the handle at the rear of the machine. The terminals for the three mains are shown on the top of the body. The coils, B, B_1, are two in number and are insulated entirely with mica and then brazed into a metal case, so as to be waterproof. This drill certainly marks considerable improvements in construction and mechanical design over any other that has come before our notice; but we still doubt its efficacy in actual work.

We shall require to hear of percussion drills working shift after shift with the regularity and certainty of compressed air ones before we are convinced of the applicability of the solenoidal drill to mining work.

A novel suggestion, due to Mr. Marvin, is the energy curve shown in fig. 2. This diagram is comparable to the indicator cards of a steam engine, and is traced in a similar way. A cylinder is mounted parallel to the drill rod and is geared to the dynamo shaft in such a way that it revolves in synchronism with it. A pencil carried by the drill rod rests upon the surface of the cylinder. It follows, then, that as the cylinder rotates once per double stroke, and the drill rod reciprocates, that a curve will be traced by the pencil. Such a curve is shown in fig. 2. The direction of motion of the paper being from left to right, the tangent of the angle made by the curve to the axis is at any instant proportional to the velocity of the plunger and the force of the impact can accordingly be calculated. The instroke is shown by the right hand concave portion of the curve, and the outstroke by the convex part to the left.

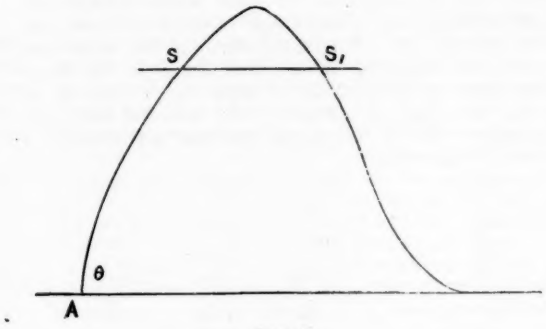


FIG. 2.

The point, A, corresponds to the impact on the rock, and the angle at θ is proportional to the final velocity. The part cut off by the line, S, S_1, indicates the action of the buffing spring. It is seen that since the slope is symmetrical above S, S_1, that no loss occurs through the cushioning, but as much energy is given out as is absorbed by the spring.

To make the test, the drill has to be fixed near the dynamo and the rotating device on the drill shaft must be thrown out of gear. But these difficulties are not to be compared with the advantage of knowing the value of the forces actuating the plunger at different parts of the stroke.

IMPROVEMENTS IN ALTERNATING MOTORS.

THE *Western Electrician* of August 6th describes in some detail the new alternating motor by Stanley and Kelly, and the principles of action are laid out quite clearly, but no statement is given as to the performance of motors constructed according to the plans described.

The plans are ingenious, but a short investigation into the matter makes it clear that the specially new device in this motor is the use of a cross magnetising coil or coils with a view to counteract the effects of self-induction in the armature.

The motor, as constructed, may be described as an ordinary continuous current dynamo, having both armature and field magnets well laminated. Fig. 1 is a diagram of the motor, in which A A represents the field core, and C C the field coils. E is the armature, a common drum armature with an ordinary commutator and brushes, F; the motor is connected as a series motor. There is nothing new in all this, so far. It is well known that if such a motor is connected in an alternating current circuit it will work as a motor, but not with any economy nor with much power; it has several serious drawbacks.

First, due to self-induction and the exciting of the magnets by an alternating current, the exciting currents are out of phase with the impressed E.M.F., and these exciting currents are required to be very large.

Second, the armature current is retarded to a greater or lesser extent than the field current; in fact, the retardation

of the armature current varies with the load, and hence the torque of the motor is never anything like proportional to the currents flowing.

Thirdly, in such a motor the alternating magnetic flux across the armature has a powerful inductive effect on the coils passing under the brushes; this effect produces heating of the coils, sparking, and waste of power.

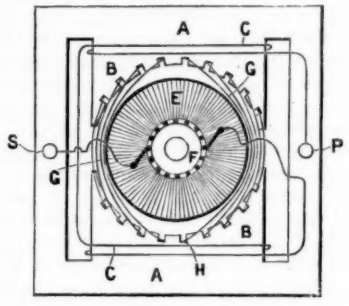


FIG. 1.

The first drawback is not touched upon in the improvements under review; it is an inherent defect in all motors excited solely by an alternating current.

The second drawback is the one Messrs. Stanley and Kelly's invention is concerned with. They propose to neutralise the self-induction of the armature by a pair of coils placed at G G in fig. 1, and let into slots on the polar faces. These coils are closed circuits, so that currents are induced in them; by the magnetic flux from the armature due to the armature current, these induced currents are opposite in direction, or nearly so, to the armature currents; hence they tend to decrease the magnetic flux from the armature, and thereby they decrease the retardation in the armature circuit.

There are other effects, however, attending the use of these coils; first, they increase the magnetic resistance of the air space between polar faces and armature, the slots, removing about one-half of the polar faces, must increase that resistance to double what it would be if there were no slots. This is a serious drawback; then the magnetic field itself must be distorted largely by the induced currents in the coils laid in the slots.

The third drawback attending the use of an ordinary motor with alternating currents is not remedied by this plan of winding. Mr. James Swinburne proposed to remove this drawback by winding the armatures double, in two circuits; the coils of the one circuit alternating with the coils of the other circuit. Machines wound in this way were, at one time, constructed by Mr. Weston for continuous currents of high pressure. By this device the coils cannot be short-circuited as they pass the brushes; such a device, however, demands a large armature to accommodate the two windings.

The same inventors claim to have devised a new method for producing a difference of phase in two branches of the

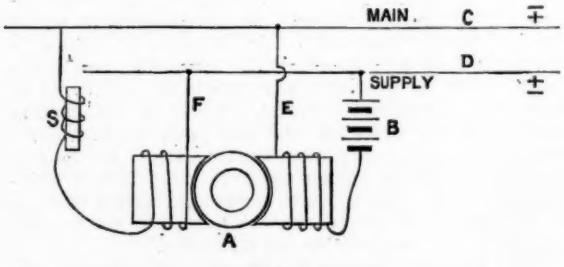


FIG. 2.

same alternating current, for the purpose of running two-phase motors. The plan is not new altogether, although it has not perhaps been described. It consists in using a counter electromotive force in one circuit, and a self-induction in the other circuit In fig. 2, is a diagram of the arrangement: C, D, are the main alternating supply wires, A is a quadrature motor requiring two currents differing 90° in phase; in one circuit, E, is placed a secondary battery, B, in the other circuit is placed a self-induction coil, S; the battery, by reason of its counter E.M.F., imparts a negative lag to the current, equal to 45° difference of phase in the circuit E.

The self-induction coil, S, produces a positive lag of 45° difference of phase in circuit F; there is, therefore, a difference of phase equal to 90° between the currents in circuits E and F.

The battery, B, is not an ordinary lead battery, and does not require any forming or charging. Lead plates used in this way in dilute sulphuric acid, are rapidly converted into sulphate; iron plates in caustic soda solution work fairly, but do not last long. Carbon plates also deteriorate rapidly; the only plates which work well and are indestructible are platinum plates, but their cost is prohibitive.

The number of plates in the battery is made so that the counter E.M.F. of the battery is sufficient to prevent actual electrolysis.

Stanley and Kelly's batteries are coupled in series with one of the circuits, as shown in fig. 2; sometimes they propose to use another battery in the main circuit to neutralise any lag therein.

Batteries may in this manner be used in place of condensers, and can also be used as condensers are used, coupled in parallel with generators or induction coils, to supply exciting currents. Fig. 3 is a diagram of an arrangement

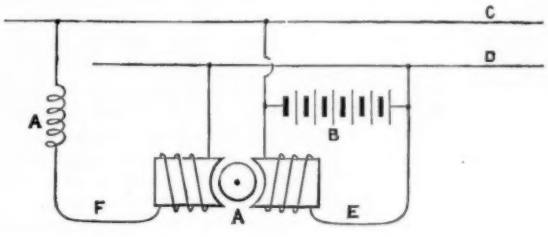


FIG. 3.

of battery and circuits used by Mr. Rankin Kennedy with his two-phase motors. In this arrangement the battery is coupled in parallel with one of the circuits; the counter E.M.F. in this case requires to be adjusted so that the maximum E.M.F. of the alternating current is just below the E.M.F. of the battery.

The Stanley-Kelly motor referred to may work with some measure of success, but the improvements seem quite inadequate to meet the difficulties in the way of working such a motor with alternating currents only. The use of a battery in place of condenser is of interest, and is no doubt a novelty to most electricians.

LIFE AND DEATH ABROAD.

FROM time to time we receive from foreign stations fragments of intelligence, telling us of the kind of life our electrical brothers have abroad, and we regret to think that the impressions are in many cases exceedingly sorry ones. Difficult as it is to cope with the adversities of humanity here at home, it is still harder to know in what manner the woes of young England may be lessened when he goes abroad.

Why did he go? Obviously because there was work to be done, and a special inducement held out in the way of increased pay. Or maybe it was on the advice of his all-knowing uncle, who has never been a hundred miles away from his native village. "It will widen your sphere of usefulness, my boy, and give you a unique knowledge of the world. You will gain a vast experience—a vast experience!"

Sometimes his lines are laid in pleasant places, and his life is a very jolly one; he finds the average Englishman abroad a very congenial person, and with a little riding and shooting, he is something more than satisfied with his position. This represents one phase of the telegraphist's life abroad, but just now we want to say a word for the less fortunate men, in the hope that something may be done to comfort and relieve them according to their several necessities. We refer to those sent off to unhealthy coast-towns, and who have to fight against fevers in an insufferable climate. Of course, it is no worse for them than for other English residents; yet we are certain that, in many cases, the condition of things might be much improved by a more careful choice of the locality of the cable-station in the town. For there is this difference between a cable office and an ordinary commercial house: that a bank or warehouse must occupy a central position, and have all its staff working together on the spot; a cable station, however, may generally be placed sufficiently remote from the town to avoid contamination. Here all "re-translation" work can be done, thus keeping the greater part of the staff in minimum danger. It necessitates a small central office in the town for "local" messages, which can be sent to and from the cable-office over a land-line. It is true that such a system is more expensive in its working; but when it can be proved beyond doubt that the death-rate is diminished very considerably by such a distribution of the staff, its initial cost should not deter its introduction wherever it is practicable.

There would appear to be another direction in which the chances of fever may be lessened, *i.e.*, the providing of well organised quarters for the men. In all cases where this has been wisely carried out the result has been in every way encouraging. Here there is great need of a practical experience; in organising such a scheme the choice must rest, to a considerable extent, with the men themselves, and every allowance must be made for variation in species. Naturally there are some who prefer a more or less solitary existence, and, again, there will be those who would choose to live collectively. It is evident that with a little well-directed foresight a very workable compromise might in each case be arrived at, so that the staff may be healthily housed.

In England, happily, it is difficult to realise conditions of foreign things, yet we are daily in possession of the benefits arising from the work of those who are placing their lives at such risk. These risks cannot be entirely removed, but it is certain that they could be most decidedly diminished by a judicious and properly organised system, and our object now is to invite our foreign telegraphists to give us their ideas on the matter.

Perhaps if telegraphists will lead the way something may be done which will advantage not themselves only, but all placed in similar conditions in fever lands. Let them tell us what quarters are most comfortable and healthy, and what arrangements seem best adapted to their needs.

THE BLACKENING OF INCANDESCENT LAMPS.*

By E. E. CARY.

THE recently published life tests of incandescent lamps, by Prof. Thomas, of the Ohio State University, have brought prominently and disinterestedly to the notice of the electrical fraternity the wide range in the blackening of the lamps during life, even when they have not been subjected to the wide variation in voltage which occurs in many of the central stations, and with which all lamp manufacturers have to contend.

Prof. Thomas's scale of blackening runs from 10 to 100, the latter representing the most blackened lamps, and he adds in his article on page 39 of the *Electrical Engineer* of July 13th, the following: "It was remarked that the two lots which were least blackened were of the makes which are advertised as exhausted by mechanical pumps. That they should both be so much alike in blackening, and both only one-half as much blackened as the least blackened of the mercurially exhausted lamps, is, to say the least, worthy of notice. It is, of course, not established that the observed freedom from blackening is due to the absence of mercury vapour in the lamps, as the makers claim, but if investigation should establish the claim, the mercury pump will probably become once more a laboratory instrument."

Naturally Prof. Thomas does not wish to affirm that the excessive blackening in mercurially exhausted lamps is due to the presence of mercurial vapour, but does state most positively that the lamps pumped by the metallic non-mercurial process showed but one-half of the blackening of the least blackened of any of the others. As this matter is of much importance to central stations, doing away almost entirely with seconds, which have to be used about the stations, and also with the many complaints from consumers on the score of blackened lamps and diminished light, it has naturally awakened much speculation as to whether the blackening is really due to the presence of mercurial vapour or not.

Further, the question arises, Why should there be such a variation in the blackening of individual lamps exhausted by the mercurial process? The latter question is readily answered, as it has to do entirely with the construction of the filament.

In a properly constructed filament three important conditions must be fulfilled. 1. It must be as dense as possible. 2. It must be uniform. 3. It must be elastic. That is to say, should all filaments be equally dense, uniform and elastic, and treated alike during exhaustion, the blackening would not vary. The wide range in blackening shows how far lamp manufacturers are at variance.

The writer after a year's experience with the metallic non-mercurial pump, in the exhaustion of several hundred thousand lamps, feels confident that ultimately it will be proven to the satisfaction of all, that the blackening in the lamps pumped by the old process, in a great measure is due to the presence of mercurial vapour. Repeated life tests have shown that with the same kind of filaments, the blackening is invariably greater when the lamps are mercurially exhausted. The vapour of mercury never disappears even if the lamp attains a life of from 2,000 to 3,000 hours. Its nature may be changed, for, when the lamp is broken under mercury, the vapour does not condense, but a small bubble from $\frac{6}{64}$ths to $\frac{10}{64}$ths of an inch is always visible.

The bubble of residual carbonaceous vapour in a lamp exhausted by the metallic non-mercurial pump may vary from $\frac{3}{64}$ths to $\frac{5}{64}$ths of an inch in diameter, but after 75 to 100 hours' burning it entirely disappears, and no trace of one is visible even with the aid of a magnifying glass. In consequence, there is attained practically a perfect vacuum and no medium exists to assist in carrying the minute particles of carbon from the filament to the inner walls of the bulb. When this medium does exist in the form of mercury vapour, it affords an easy passage for the loosened particles of the filament to the bulb.

One important matter must be borne in mind when speaking of the blackening of lamps. Ordinarily one might think that the diminution of light is entirely due to absorption by the blackened walls of the bulb, whereas in reality this accounts for but part of the loss, for the filament is reduced in mass proportional to the blackening and consequently offers an increasing resistance to the E.M.F. which latter we may assume constant. Therefore the filament itself constantly emits less and less light, which, together with the increasing absorption, rapidly destroys the value of the lamp. This will impress upon the mind that if disintegration of the filament can be stopped, the normal strength of the filament will be retained, the lamp will not blacken, but will remain bright to the eye till broken.

Since but one company has operated the metallic non-mercurial pump (though their lamps have appeared under different names), others interested have been unable to determine the matter for themselves. It is to be hoped, however, that disinterested tests will be made during the coming year, to prove to the satisfaction of all interested parties the causes of the great *bête-noir* of blackening.

* New York *Electrical Engineer*.

EXHAUSTING INCANDESCENT LAMPS BY MEANS OF MERCURY PUMPS.*

BY J. W. PACKARD.

I DO not wish to enter into a discussion regarding the relative merits of mechanical *versus* mercury pumps as used in exhausting incandescent lamp bulbs, but simply to correct a generally accepted opinion that the cost of lamp making will be materially reduced by the adoption of the mechanical pump. The following are the actual figures of the cost per lamp in the pumping department of a medium sized factory, exhausting about 2,000 lamps per day :—

Labour, pumpers	$0.00727
„ glass blowers	.00583
Repairs and supt.	.00191
Material	.00077
	$0.01578

This gives a total of a trifle over one and one-half cent per lamp.

These figures are from actual practice, and will of course vary slightly, but are neither above nor below the average, and represent the total cost of pumping for finished lamps. In some larger factories I have no doubt that the cost is materially less than this, while in others it probably runs up as high as three to four cents per lamp. There is a mistaken impression that mercury pumps as at present used require a great deal of attention. In the case of the factory mentioned above and in any well-equipped modern lamp factory, using the so-called Geissler pump, the pumps are absolutely automatic, the mercurial pistons rising and falling with clock-like regularity during the entire time that the factory is in operation, the labour of the pumpers consisting solely in placing the lamps on the pumps, in turning on and regulating the current and in removing the lamps at the proper time. It is manifest that this labour cannot be reduced by the employment of the mechanical pump, however perfect and rapid its action. The labour of the glass blowers, too, in attaching the lamp to the pump connections and in sealing off the tubes through which they are exhausted must be the same, whatever kind of pump is used. It is difficult to see how the items above mentioned, of repairs and superintendence, and of materials which consist of acid, oil, waste, &c., can be much reduced.

In the above-mentioned system of pumping, which is in almost universal use in this country, it is of course understood that the atmospheric pressure is never admitted to the operating bulb of the pump and that the preliminary exhausting of the lamp before connection with the mercury pump is established, is done by means of a mechanical pump, this operation consisting in the mere opening and closing of a stop-cock. The mechanical pump used for this purpose is almost without exception the Packard pump, which is a modified form of the Ritchie and gives in regular use a vacuum approaching to within ½-inch of the barometric pressure. The size of the mercurial pumps used is limited not so much by the difficulty of constructing and operating them, as by the undesirability of attempting to exhaust more than a certain number of lamps on one pump at a time, as a leak or defect in one would destroy the vacuum in all of the lamps on that pump. The pumper's most difficult task is, when a leak is developed on a pump, to discover the defective lamp in order that it may be removed and the exhaustion of the remainder proceeded with. This difficulty would be greatly increased in the case of the mechanical pump, where it is claimed 600 lamps are pumped at one time, and it would be impossible to secure a perfect vacuum until all leaky lamps had been removed.

The time taken for exhausting too, is dependent as much upon the slow and careful electrical treatment to which it is necessary to subject the carbon at this stage, as upon the displacement effected by the pump piston.

From the considerations and figures given above, it is manifest that the claims made by the inventors of mechanical vacuum pumps for the complete exhaustion of incandescent lamps, that a saving of 8 cents, or more, per lamp, can be effected by the substitution of mechanical for mercury pumps, are absolutely without foundation, since, supposing that the entire operation and cost of pumping were done away with, a saving of but 1½ cent per lamp could be effected.

In one of the mechanical vacuum pumps for this purpose the inventor states that he uses a non-volatile liquid and that a vapour of oil or hydrocarbon is left in the bulb, presumably from this liquid. The claim is made too, that a vapour of mercury is left in lamps exhausted by the old process, which is very injurious to the lamp, causing a rapid blackening. I am unacquainted with any authority for, or any evidence which would tend to sustain, this statement. In the recent test by Prof. Thomas, at the Ohio State University, the "Packard" lamps, which are exhausted by the mercurial process, showed considerably less blackening than any of the other makes, among which was the "Beacon" which is exhausted by the mechanical process. The leaving of a vapour of hydrocarbon in a finished lamp has often been tried and at one time was quite extensively practiced at one of the largest lamp factories in the country, but was soon abandoned as being of no utility. The presence of any vapour in a finished lamp imparts a dull appearance to the carbon and makes the bulb distinctly visible, it appearing to be of a slight yellowish tinge. In all the mechanically exhausted lamps which I have examined, this appearance is quite marked.

* New York *Electrical Engineer*.

REVIEWS.

A Dictionary of Electrical Words, Terms, and Phrases. By E. J. HOUSTON. Second edition, re-written and greatly enlarged. New York: The W. J. Johnston Company, Limited, 167—176, Times Building.

Those who have copies of, or who recollect, the first edition of this work, will be much struck by the great advance in every way which is marked in the present edition. Speaking, generally, it may be said that the size of the book has practically been doubled, the number of definitions being about twice as great as was the case in the original work. There are many to whom the new edition will be welcome; not only will students and members of the rising generation have their studies in electrical science made easier and clearer by frequent references to the pages, but many of the older school, whose work has so long been in one groove that they experience a difficulty in grasping what to them are "new fangled" terms, will be glad to be enabled to keep up to, if not in advance of, the times, by frequent dips into Professor Houston's excellent production.

Elementary Treatise on Electricity and Magnetism (Trattato elementare di Elettricità e Magnetismo). By Dr. Giorgio Finzi. With 183 illustrations. Milano: Office of the Revista *L' Elettricità*, 2, Via Merasigli, 1892. 8vo., pp. 503. Publishing price, 6 lire (5s.)

Some twenty years ago, every man of higher education thought it necessary, as one of his youthful indiscretions, to write an elementary chemical manual. Such works contained, as a rule, nothing erroneous, but nine out of ten of them had no *raison d' être*; they were merely repetitions in slightly modified language of what had been said before. Now we most devoutly hope, for the sake of professors, of students, and above all, of reviewers, that no similar destiny awaits electrical science in the near future.

The work before us opens with general considerations on matter, energy, and electricity. The author then proceeds to measurement in general, to electrisation, induction, condensation, electric discharges, and electrometry. Next follow magnetism, electric currents, electro-chemistry, thermo-electricity, electro-magnetic induction, electro-magnetic radiation and electricity and magnetism in nature.

Lastly comes an exposition of the relations between electricity and life. But we think the quacks will find here little to gladden their hearts or support their exorbitant pretensions.

Throughout the work the phenomena and the laws of electricity are clearly and ably explained, and there is no attempt to indulge in vague speculations or to be wise above what is demonstrated.

The illustrations are the weakest side of the book; many of them cannot be pronounced other than bad; the lettering and the explanatory references are sometimes wanting.

There is a table of contents at the end of the volume, but no index, which is to be regretted.

Electricity: its Theory, Sources and Applications. By J. T. SPRAGUE. Third edition, thoroughly revised and extended. London: E. & F. N. Spon, 125, Strand.

Mr. Sprague is nothing if he is not original, and the boldness with which he entered into print with his original work on electricity, though it met with much opposition and sarcasm has been justified by success. In his preface Mr. Sprague somewhat ironically remarks: "There are two electricities known to the scientific world, the electricity which exists in nature, and the electricity which, created by mathematicians, exists chiefly upon the blackboards of the professor's classrooms." There is, no doubt, a certain amount of truth in the inuendo expressed in this somewhat inaccurate sentence—we say inaccurate, for professors do not "create" the electricity, but simply explain its effects, and deduce the laws of its actions by mathematical analysis—but at the same time it is distinctly the enunciation of one who not a mathematician himself makes up for his ignorance by sneering at those who, being better informed on the subject, appreciate the value of mathematics. We, however, fully admit that "professors" often set forth their explanations in a manner which, although perfectly clear to themselves and to those who have a natural talent for mathematical analysis, is by no means clear to others whose faculties are differently constituted. To the latter class of readers Mr. Sprague's work is admirably suited. Compared with the original edition, one-third of the book has been re-written, and with considerable advantage, as it has been thereby brought up to date. An important feature is, that the instruments necessary for the study of principles have been fully explained, so that those who have an aptitude for mechanical work can construct them for themselves, which, as Mr. Sprague most truly remarks, is "the best possible way of understanding them." Much of the new matter is a compilation from articles by the author which appeared in the *Electrician* and *Electrical Engineer*.

Journal of the Institution of Electrical Engineers. No. 100. London: E. & F. N. Spon, 125, Strand.

The chief contents of this number are as follows:—"Electrical Distribution by the Newcastle-on-Tyne Electric Supply Company, Limited," by A. W. Heaviside and R. C. Jackson; "The Problems of Commercial Electrolysis," by J. Swinburne.

Useful information and Data for Travellers, Railway Men and Mechanics. Compiled by T. J. NICHOLL. Second edition. Chicago: Danks & Company.

This is a small book (of 62 pages), chiefly of value to Americans, as a considerable portion relates to matters, such as statistics and law, which does not concern Europeans. It is practically a very condensed Molesworth, and contains handy information.

Electric Lighting in Hong Kong.—At the third annual ordinary meeting of the Hong Kong Electric Company, the chairman said he regretted that the branch of incandescent lighting had not been more extended, but he thought the cause was not far to seek, and they must continue to hope that when the colony returned to its normal state of prosperity, the hopes entertained when the company was formed would be realised and so enable the directors to make some tangible return to shareholders. The working of the company for the twelve months showed an advance in the right direction, and in another year's time they would be in a still better position. Their plant was capable of supplying a very large addition to the amount of incandescent light at present in operation, so that the increased consumption would materially augment their revenue at a minimum extra outlay. After some discussion the report and accounts were adopted.

NOTES.

The Magnetism of Organic Compounds.—The magnetic constants of a considerable number of organic compounds have recently been investigated by S. Henrichsen under varying conditions. It was found that every substance which was placed under examination behaved similarly with respect to the magnetising force. If the magnetising force be designated by K, and the diamagnetic deflection by the letter A, then what was observed may be summed up under the statement that as K increased, the quotient $\frac{A}{K^2}$ rose slightly and then fell off. This statement may be illustrated with the following numbers for propyl formate, taken from Henrichsen's results:—

K	A	$\frac{A}{K^2}$
82·7	32·3	0·00595
116·0	65·4	0·00612
146·1	103·6	0·00613
178·6	152·4	0·00602

The function $\frac{A}{K^2}$ is considered by Henrichsen to be in reality a constant. Measurements of the temperature coefficient between 20° and 90° were undertaken, and gave values of a for the different substances, ranging from 0·00103 to 0·00156 in the formula

$$M_t = M_0 (1 + a t),$$

where M is the magnetism. The mean of the values for a is 0·00133, which may be adopted for all the compounds investigated. Henrichsen gives several measurements in absolute units. For further particulars, the original paper may be consulted in the *Annalen der Physik und Chemie.* Series 2, Vol. xlv., pp. 38—61.

The Temperature of Incandescent Lamps.—There is an idea that the temperature of a body should be proportional to its brilliancy and to the quantity of fuel consumed in heating it, but these factors in reality increase much more rapidly than the temperature, and at present form a poor guide. Dependence upon them has led to exaggerated notions of the temperature developed in industrial furnaces, *e.g.*, steel melting and blast furnaces, and perhaps, also, the pyrometric methods commonly employed in determinations of such temperatures are unreliable. We have already alluded to the new form of pyrometer that has recently been developed by Mons. H. Le Chatelier, and noted its interest to electricians. By means of it he has succeeded in measuring a large number of reputed high temperatures, and amongst them that of the average incandescent lamp, this he finds is about 1,800° Centigrade. This determination was made on lamps in ordinary working order; when hard-pressed, such lamps may exceed 2,100° Centigrade. Query: without injury?

An Application of Electrolysis.—The measurement of density has recently been applied by Mons. A. Leduc, of the Paris Academy of Science, to the determination of the atomic weight of oxygen, in a way involving the use of electrolysis. He found the composition of water by volume, and thence its composition by weight, by determining the density of a mixture of hydrogen and oxygen produced by the electrolysis of an alkaline solution. After an electrolysis which lasted several days, during which the superfluous gas was allowed to escape through mercury, the liquid and the platinum poles were saturated with gas, and the density obtained by the method previously described did not vary by more than 0·0001 gr. Hence the method must be exceedingly accurate. The value within $\frac{1}{100}$th per cent. was 0·41423. Our chemical readers will be interested to see that this method places some of the constants of oxygen rather lower than they are stated in the text books. The volume ratio between hydrogen and oxygen was 2·0037 at 0° C., and the atomic volume of oxygen 1·9963. The atomic weight of oxygen worked out to 15·877 by this method, and by the synthetic method to 15·882, so that 15·88 must be taken for the mean atomic weight. From these results it follows that 17·88 is the molecular weight of water vapour and that its theoretical density is 0·622.

An Improvement in Producing Aluminium.—The following constitute the essential features of Grabau's improvement in producing electrolytic aluminium, and will be interesting in view of the publicity recently given to the methods of extracting this metal. The difficulties which occur in the manufacture are, some of them at least, due to the presence of silicon and iron, and these are avoided by using, as the material for electrolysis, a mixture of aluminium fluoride with soda, or other basic substance, which can be easily obtained free from these impurities. Cryolite is fused by the agency of the current, and to this is added, during electrolysis, a mixture of aluminium fluoride and soda, in definite proportions, according to the quantity of aluminium to be separated. The proportion between the aluminium fluoride and the soda may be such that, besides aluminium, sodium fluoride, or chiefly cryolite ($Al_2 Fl_6$ 6 Na Fl) is formed. Any proportion lying between these two extreme cases, which may be represented by the following formulæ, may be employed, viz.:—

i. $2\ Al_2 Fl_6 + 6\ Na_2 CO_3 + 3\ C = 4\ Al + 12\ Na\ Fl + 9\ CO_2$

ii. $4\ Al_2 Fl_6 + 6\ Na_2 CO_3 + 3\ C = 4\ Al + 2\ (Al_2 Fl_6\ 6\ Na\ Fl) + 9\ CO_2$.

Potash may obviously be substituted for soda, if the corresponding potassium compounds are used. The positive electrode must be carbon, the negative may be a metal such as aluminium.

The Occlusion of Hydrogen by Metals.—Here is an example of the way in which a knowledge of electrical behaviour will assist the chemist in elucidating obscure points in chemistry. When colloïdal silver is heated with hydrochloric acid, it may be expected that silver chloride and hydrogen will be formed. If so, the hydrogen must be occluded by the silver as no gas escapes, and, on electrolysis, in a properly-arranged apparatus, it would be expected to reveal its presence by the effect of the polarisation current on the electromotive force of the solution. From such measurements E. A. Schneider has recently concluded that the silver particles do occlude hydrogen, which they slowly lose during electrolysis. Could not this method be employed towards deciding other cases in which the metals of secondary batteries, &c., for instance, have been alleged to occlude hydrogen?

Apropos of the above remarks on the occlusion of hydrogen by lead in secondary batteries, it may be added that even under the most favourable conditions this metal is incapable of occluding the gas to any extent worth taking into account, hence certain physical phenomena which occur at the negative plates cannot be explained by the assumption of Neumann and Streinte. Recent experiments with hydrogen passed over molten lead only showed from 0·11 to 0·15 of its volume of hydrogen taken up by lead. Comparative experiments with other metals show the following results, the mechanical conditions, however, not being always the same:—

Palladium	...	502·35	times its volume.	
Platinum	...	6·48— 49·30	"	"
Gold	... ...	37·31— 46·32	"	"
Copper	... ...	4·78— 4·81	"	"
Nickel	... ...	16·85— 17·57	"	"
Cobalt	... ...	59·31—153·00	"	"
Silver	... ...	*nil.*		

The Chemical Changes attending Photographic Operations: An Analogy.—Prof. Armstrong in a recent paper dealing with this subject describes the electrolytic action of the De la Rue-Müller cell, and compares it with the similar action which attends photographic development in a manner which will be highly interesting to any electricians who dabble in photography, or who use it in pursuing their researches. The professor, contrary to Mendola's view, suggests that the invisible image is not the same as the darkened product formed by the "developer," *i.e.*, an oxyhaloid compound of silver; that there are perhaps two latent images formed, one by the blue and the other by the yellow rays, these behaving differently during development. The blue image being silver and the yellow an oxyhaloid of silver, the former is comparable to the silver wire in the De la Rue-Müller cell, whilst in the case of the latter the silver bromide undergoes electrolysis in a circuit which includes oxygen, the halogen which is liberated converting the metal formed by the action of the blue rays into silver haloid.

Testing Le Chatelier's Thermo-Elements.—Some experiments have recently been carried out by Drs. Holborn and Wien on the measurement of high temperatures, with a view to ascertaining the sensitiveness of the platinum-rhodium thermo-elements, which Mons. Le Chatelier has devised. The air-thermometer was used as a standard. Into the cavity of the porcelain tube, the thermo-elements were placed, and the readings of the two instruments were then compared within a range of temperature — 80° C. and + 1,500°. It was found that Le Chatelier's device can only be advantageously used for recording high temperatures. This, by the way, was its *raison d'être*. Below 500° C. the thermo-element is not very sensitive. Le Chatelier uses an alloy containing 10 per cent. of rhodium, and this proportion was found to be the most suitable for the purpose, although alloys of platinum with from 9—40 per cent. of the other metal gave a higher electromotive force.

Electricity at the Conservatoire des Arts et Métiers.—Colonel Laussedat, director of the Conservatoire des Arts et Métiers, has just published a pamphlet descriptive of the electrical installations in the establishment under his direction, and showing how the electric lighting has been carried on. In 1886 there was a Belleville boiler and a compound steam engine of 50 H.P., made by Messrs. Weyher and Richemond. The machines installed were the compound Gramme machine, of 110 ampères and 80 volts at 1,400 revolutions per minute, feeding 10 Cance arc lamps and three incandescent lamps, one Breguet machine of 80 volts and 80 ampères at 1,400 revolutions per minute; an Edison machine of 110 volts and 40 ampères at 1,400 revolutions per minute, and a Gramme machine of the workshop type, giving 60 volts and 25 ampères at 1,140 revolutions per minute. By this means during the winter of 1886—7, the principal lecture rooms and the machine rooms were lighted. In 1887, an 8-H.P. Otto gas motor was introduced for lighting the library, in order that the steam engine might not be used for this purpose alone, the evening lectures being suspended. A battery of 30 Planté accumulators was also added. Three new dynamos were installed, viz., a Gramme machine, giving 78 volts and 55 ampères at 1,400 revolutions a minute; an Edison shunt machine, giving 115 volts and 85 ampères at 1,200 revolutions per minute; a Gramme shunt machine, giving 70 volts and 30 ampères. At the end of 1889 two more Edison machines were added, both of 115 volts and 85 ampères, and a second battery of 30 accumulators was installed. The electric lighting could then be effected by nine dynamos, producing altogether 600 ampères, and capable of maintaining 252 incandescence lamps and 20 arc regulators. In 1891 more cables were laid, so as to bring the current to the professors' tables and into the laboratories. At the end of 1891 and the beginning of the present year, it became necessary to have a constant source of electricity, on account of the experiments undertaken in the different laboratories. The Minister of Commerce and Industry then sanctioned a contract between the direction of the Conservatoire and the Electric Lighting and Power Company for the supply of electrical energy, either by day or by night. It would have been interesting to know at what price the hecto-watt hour was supplied; but we have no information on this point. No doubt it was not thought expedient that the price agreed to by the Conservatoire des Arts et Métiers should be known all over Paris.

The Dissociation Heat of Electrolytes.—When a scientist broaches a new and far-sweeping theory, he does well to secure himself from attacks, which, though of little moment, may vitiate his general standing. Van der Waals, Nernst, Jahn and Trevor have all pointed out a discrepancy which occurs in S. Arrhenius's calculation of the heat of dissociation of electrolytes, and there have not been wanting those who were ready to consider his other work on the dissociation theory as somewhat stultified by these discoveries. In a recent paper published in the *Zeit. Physikalische Chemie*, ix., p. 339, Arrhenius has made the necessary rectification, and has recalculated the heats of dissociation of a number of electrolytes. The error, however, did not seriously affect the credit of the general hypothesis.

Oxygen and the Electro-Magnetic Theory of Light.—The spectrum of liquid oxygen and its refractive index has lately formed the subject of a research by Profs. Liveing and Dewar, but the inherent difficulties of manipulation, together with the conditions of extreme cold and pressure under which the experiments have been conducted, have hitherto prevented these scientists from determining the refractive indices for rays other than D. We are glad, however, to hear that this investigation will be pushed further, with a view to determining these physical constants, for there is little doubt that the value of the refractive index of oxygen has an important bearing on the electro-magnetic theory of light. Liquid oxygen, it must be remembered, is a magnetic liquid.

Electric Cranes.—The motor seems to be rapidly gaining favour for use on travelling and derrick cranes, &c. Indeed, to quote the *Electrical Engineer* of New York, "electric motors have revolutionised the crane business, and, to-day, the three-motor cranes (one motor for each motion) are in demand, in preference to all other methods, for any kind of work whatsoever." We, in Great Britain, cannot endorse this view so thoroughly, though electricity is daily gaining ground, and must ultimately supersede all other means of transmitting power in a very large number of cases. The American Brush Company have recently erected a 15-ton travelling crane at their works. They have found it expedient to use three slow-speed motors, and we concur in the general arrangement of the details, which seems to meet all the requirements of work in a ready and efficient manner. Each motor has a separate rheostat and switch, which starts, stops, reverses, and governs the speed, independently of the other machines. By these means friction clutches and reducing gearing are obviated.

The Post Office.—The thirty-eighth report of the Postmaster-General on "The Post Office," which has recently been issued, states that during the twelve months ending March 31st there was a grand total of 2,710,578,365 letters, post cards, book packets, circulars, samples, newspapers, and parcels delivered in the United Kingdom. The total number of officers on the permanent establishment of the department, together with sub-postmasters, is 68,231. Altogether, there were in the employ of the department 125,762 persons, of whom 16,000 were women. The new telegraph money order business, although restricted until the last month of the financial year to head and branch offices only, showed a considerable expansion, there having been 42,055 such orders issued in 1891-92, as against 30,196 in 1890-91, while the amount remitted was £157,428, as compared with £112,570. On March 1st last the system was extended generally to all money order offices in the United Kingdom which are telegraph offices, and this extension has naturally given an increased impetus to the use of the system by the public. In the three months following the introduction of the extended system, the total number of telegraph money orders was 15,845, and the amount was £57,155, as compared with 8,670 orders amounting to £31,665 for the corresponding period of 1891, an increase of over 80 per cent. The system appears to be used by tradesmen who require orders to be executed immediately, by tourists, and the travelling public generally. The number of postal orders issued in the United Kingdom was £52,659,545, or £3,817,780 more than in the previous year. The value represented by the orders was £28,563,750, or £1,385,382 more than the value of those issued in 1890-91. The total amount transmitted by money orders and postal orders in the year was about 49 millions sterling, or 2 millions more than in 1890-91. The number of ordinary inland telegrams despatched was 57,085,939, and their total value £1,848,974. The results of the working of the London-Paris telephone, which was opened on April 1st, 1891, have been satisfactory. The number of conversations has increased from 1,221 during the month of April, 1891, to 2,157 in April, 1892, and it has been necessary in consequence to allocate a second circuit for the purpose. The charge is 8s. for a conversation of three minutes, and the receipts for the year amounted to £4,616. The deficiency with respect to the telegraph service, taking into account the revenue, the cost of the service, and the interest on the capital expenditure, was £384,662 for the past year.

The Electrolytic Determination of Metals as Amalgams.—In 1883, W. Gibbs read a paper before the National Academy of Science, U.S.A., on a method of electrolysis for the separation of metals from their solutions by the use of mercury as the negative electrode, the positive electrode being platinum. He showed that iron, cobalt, nickel, zinc, cadmium, and copper can be completely separated in the form of amalgams from a solution of their sulphates in this way. Brown has gone further, and has shown (*vide* a paper in the *Transactions of the Institute of Mining Engineers*) that iron may thus be separated from even traces of alumina, and it seems probable that iron, and some other metals may also be separated from titanium, zirconium, niobium, and tantalum, and that the electro-negative portion of certain metallic salts may be estimated by this method of electrolysis. Lückow has already estimated zinc by it (*vide Zeits. Anal. Chem.* xxv., p. 113), and Vortmann has used the method for determining mercury, zinc, cadimium, lead, bismuth, and antimony (*vide Berichte* xxiv. p. 2,749).

Electro-Photo Detective Thief Catcher.—A very interesting description of a somewhat novel invention for capturing burglars is given in the columns of the *Scientific American*. A cigar merchant in Ohio, had for some time missed cigars, which were removed from his show cases by some clever thieves. Attempts to detect the culprits proving fruitless, he had a flash light photographic apparatus set up and arranged in working order, with the hope of securing photographs which would lead to the identification of the thieves. Early one morning two boys entered the place, opened the case, and in so doing set the apparatus in operation, thus making a record of their deed and furnishing evidence of their guilt. The two lads, it seems, in the act of opening the case, closed an electric circuit, which released the camera shutter, and at the same instant operated the flash light apparatus which photographed the boys in the act of removing the cigars. The patentee of the apparatus is Mr. W. H. Harbeck.

Earthquakes, Electricity, and Vegetation.—When people tell us that earthquakes are capital things, we may reasonably be allowed to entertain suspicions regarding their sanity; but if they follow up their assertions with reasonable argument, then we must, perforce, give them some attention. Signor A. Gioran has been collecting a number of observations from which he deduces that the effects of seismic shocks upon vegetation are to favour a more rapid germination of seeds, and a more rapid growth of the young plants, thus resulting in a greatly increased luxuriance. These results, he believes, to be due, not to the direct influence of the tremor, but to three secondary causes, amongst which is the production of electricity, which always accompanies stresses in the earth's crust. In connection with this, we may notice some experiments by Prof. A. Aloi, on the influence of atmospheric electricity on the growth of plants. From observations made chiefly on *Lactuca Scariola*, *Zea Mais*, *Triticum æstivum*, *Nicotiana Tabacum*, and *Vicia Faba*, he concludes that this influence is distinctly beneficial. Further experiments have demonstrated that the electricity of the soil has a similar influence on the germination of seeds.

The Electrolytic Separation of Iron and other Metals.—Every week almost we notice that electricity is becoming of more assistance to the assayer and the analyst. Iron can now be separated from solutions by first converting it into ammonio-ferrous tartrate, and then electrolysing the solution by the action of a feeble voltaic current equivalent to the liberation of about 3 cc. of oxyhydrogen gas per minute. The iron separates in a very compact form, but contains a little carbon: this can, however, be got rid of by ignition if necessary. The method can, according to E. F. Smith and F. Muhr, be employed for the separation of iron from aluminium. By employing currents generating 1·8 to 2 cc. of oxhydrogen gas per minute, gold may now be satisfactorily separated from arsenic from molybdenum, or from tungsten. For separating gold from osmium, cadmium from osmium, or silver from osmium, a current evolving 2·4 cc. oxyhydrogen gas per minute is required. In parting mercury from osmium the current must evolve 0·7 to 1·9 cc. of the mixed gas per minute, whilst in separating cadmium from nickel the current should evolve 2 cc. of gas per minute.

Electric Traction in Japan.—It is stated that an electric railway is to be built at Kobé, Japan, to give readier access to the mountain resorts, and direct communication with the Wakasa Gulf.

The Electric Light in Exeter.—The work of changing the system of electric lighting in this city from overhead to underground has been proceeding for about eight weeks, and in a fortnight more is expected to be at an end. The work has proceeded rapidly and satisfactorily under the direction of the Exeter Electric Lighting Company. Already the mains have been laid in most of the principal streets. The present area is considerably more extensive than that embraced by the overhead wires.

New Light on Solar Phenomena.—Dr. M. I. Papin has just brought to a satisfactory conclusion one stage of his investigations on electrical discharges in partial vacua. The results so far obtained seem to throw considerable light on the nature of the solar corona, solar prominences, solar faculæ, and the aurora borealis. We understand that he intends to continue his researches on the same lines, but by somewhat improved methods of examination. So far, he has employed the ordinary alternating current of about 125 $\sim$ per second, but now he proposes to use electrical oscillations of several hundred thousand per second, and is building for that purpose a very large oil condenser, capable of withstanding a tension of 20,000 volts. The oscillatory current will be transformed to very high voltage by means of an oscillating current transformer.

Electric Launches at the Chicago Exhibition.—According to the New York *Electrical Engineer*, the announcement that the contract for supplying launches to convey passengers on the lagoon at the Columbian Exhibition will be awarded to an electric company is interesting as confirming faith in the feasibility and utility of electric navigation under the conditions to be met with at Chicago. The craft submitted for test were ten in number, and we append particulars as to name and description of vessels:—Steam launch *America*, steam launch *Isabella*, naphtha launch *Chicago*, oil launch ———, electric launch *Electra*, electric launch *Volta*, electric launch *Ferdinand*, electric cab boat ———, hydrocarbon cab boat ———, pneumatic launch *Pneumatic*. Of the above boats only the *America*, *Isabella*, *Electra* and *Volta* were generally considered to be in the contest for the franchise, some of the others having been submitted as suggestions, especially the "cab boats" (small boats intended not for schedule trips, but for small parties engaging them by the hour). The *America* was larger than called for in the specifications, and, although a very creditable boat, the general impression was that she was too large for lagoon service. The *Isabella*, *Electra* and *Volta*, were of about the dimensions called for. Each boat was tested with a full load on a 10 hours' run and each had a special day for the test. The several boats mentioned made the following records:—*America*, 53 trips; *Isabella*, 48 trips; *Electra*, 45 trips; *Volta*, 33 trips in 10 hours, including stops. The electric launch *Electra* carried 62 cells on board weighing about 2,400 lbs., and the *Volta* 104 cells, weighing about 4,160 lbs. While both steamboats named were excellent boats of their class, the performance of the *Electra*, together with her attractive appearance and other advantages as compared with steam, gained for this boat a recognition which gradually crystallised into preference, and it effectually demonstrated that electric launches are not merely a possibility but an achievement which the steamboat men were forced to recognise, notwithstanding their confident predictions that electricity would fail to come up to the mark. The only electric boat approved by steamboat men was the *Ferdinand*, which would not go at all, and was therefore withdrawn. The *Electra* performed better in Chicago with 62 cells than in Newark (before shipment to Chicago) with 78, owing to the fact that all the "kinks" due to warping and swelling of the timbers when the boat was still "green" had been removed and everything brought to a settled and normal condition.

Electric Lighting of Southampton Pier.—With reference to our note on this subject last week, Messrs. Statter and Co. write as follows:—"We notice a paragraph at the top of page 265 of last week's issue, headed as above. The paragraph, after referring to the lighting of the pier, goes on to state—'The electrical engineer reported visiting the works of Messrs. Stothert & Pitt, and it was resolved that they should be permitted to complete one of the electrical cranes first.' It is not quite clear from the context what these cranes are; but we presume the cranes referred to are those on the Town Quay, the contract for which has been placed with us by the Harbour Board, and we have received a notification that, in accordance with our suggestion, the board sanctioned the completion of one crane first. It is true that the gantry and crane work are being made for us by Messrs. Stothert & Pitt, and that Mr. Aldridge (the engineer of the Harbour Board) visited Messrs. Stothert & Pitt's works with Mr. Statter; but we think your paragraph would lead the public to think that the tender for the electrical cranes had been let to Messrs. Stothert & Pitt. We shall be much obliged if you will kindly correct this in the next issue of your very valuable paper."

Milan Exhibition.—A group of gentlemen in Milan, prominently connected with the professional and industrial interests involved, have taken steps to organise an International Electrical Exhibition, to be held there in the spring of 1894, and a committee has already been constituted to carry it out. As it is important that they should be able to decide on the size of the buildings required for the exhibition, the committee ask that those interested in the technical applications of electricity, makers of machinery, apparatus, &c., who desire to exhibit, should send in a form of preliminary demand. The date for sending in this form expired on the 15th ult., but no doubt it would be received later. The committee do not insist upon a formal engagement as to the number and description of the exhibits, but simply require an assurance of the intention to exhibit, and an approximate estimate of the space desired. The space is to be paid for by exhibitors at a moderate rate. In order that the exhibition may open a field of serious investigation to all interested in the marvellous progress of electricity, and the branches of engineering connected therewith, it is desired that in erecting the engines, boilers, and electrical apparatus of every description, proper measures should be taken to enable their being tested with the view of ascertaining their comparative efficiency. A considerable sum of money will be put at the disposal of the jury, in order that a large premium may be allotted to the exhibit embodying the most important invention or improvement brought forward at the exhibition, especially in as far as the transmission of electrical energy to a distance, and its sub-division and distribution for industrial purposes, are concerned. The following is a summary of the programme:—Generators of electricity; means and apparatus for transmitting and distributing electrical energy (transformers or converters, secondary batteries, &c.); apparatus for the utilisation of electrical energy (electric motors and their application to the propulsion of carriages, boats, &c., to industry, agriculture, and mining, electric lighting, thermal applications of electricity, electrolysis, &c.); telegraphs and telephones (electric signalling and its applications to railways, mining, navigation, and other purposes); instruments for scientific and practical tests; applications of electricity to medicine and surgery; raw materials and manufactures in use in the electric industries (bare and insulated conductors, insulators, insulating materials, carbons, &c.); hydraulic prime movers, steam, gas, petroleum, air, and all kinds of heat engines; steam boiler fittings, and all kinds of mechanical apparatus used in connection with electrical plants; electrical apparatus for school use; apparatus and other valuable things of historical interest; books and papers relating to electricity; plans of electrical plants, both in actual working and not yet carried into effect; reports as to the results of public and private electric plants. Further information may be obtained from any of the following gentlemen, who are members of the committee:—Angelo Bertini, electrical engineer; Francesco Grassi, Professor of Physics at the Società d'Incoraggiamento d'arti e Mestieri; Palamede Guzzi, engineer; Cesare Saldini, Professor at the Instituto Tecnico Superiore; Augusto Stucchi, manufacturer.

Telephones in Austria.—The *Standard* states that a telephone line, connecting the cities of Vienna, Graz, and Trieste, will be opened this week.

Obituary.—The *Journal Telegraphique* announces the death of Mr. C. T. Nielsen, Director-in-Chief of the Administration of Norwegian Telegraphy, which took place at Christiania on August 1st, in his 74th year. Mr. Nielsen had taken part in all the International Telegraphic Conferences since that held at Paris in 1865, representing Norwegian interests. His diligence and his large experience of the telegraph service, gained for him considerable respect and a prominent position amongst the delegates at those conferences. The regret in Continental telegraphic circles at the loss of Mr. Nielsen is most profound. He was but a year senior to Cyrus Field, who passed away about a fortnight before him.

We regret to hear of the death of Mr. F. N. Gisborne, F.R.S.C., C.E., Superintendent of the Canadian Government Telegraph Service, which took place on Tuesday morning last at Ottowa. At the time of his decease he was in his 69th year. A few years after leaving England in 1842, Mr. Gisborne went to Canada, where he was, after a short time, appointed general manager of the British North American Electric Telegraph Association, and was instrumental in erecting a telegraph line from Halifax to Amherst for the Government of Nova Scotia. Early in the year of 1849 he assumed the office of superintendent of the Government lines at Halifax, and carried out practical experiments for conveying electric signals through submerged uninsulated metallic circuits. In 1852 he was successful in laying the first ocean cable on the Canadian side of the Atlantic, connecting Prince Edward Island with New Brunswick. Two years later, in conjunction with Cyrus Field and other gentlemen, Mr. Gisborne assisted in the formation of the New York, Newfoundland, and London Telegraph Company. Mr. Gisborne's name is known in connection with many useful inventions. In 1879 he became superintendent of the Dominion Government Telegraph and Signal Service, which position he occupied until very recently.

Telegraphs and Telephones in Switzerland.—Some very detailed statistics regarding the working of the telegraph and the telephone in Switzerland during the year 1890 are given in the *Journal Telegraphique*. The article, which is an interesting review of the year's progress, goes minutely into the number of telegraph offices and telephone exchanges, &c., in the principal towns and places in that country. There has been a large increase in the use of the telephone over that of the previous year. There is an increase of 30·2 per cent. for urban conversations, 19·2 per cent. for interurban conversations, and 5·9 per cent. for the transmission of telegrams by telephone. The total amount of telephonic communication shows an augmentation of 28·4 per cent. The same contemporary, in another article, gives very lengthy accounts of the results of the working of the telegraphs and telephones in Austria and Sweden during the year 1890.

Magnetic Photography.—The *Scientific American* states that Prof. E. J. Houston describes his new mode of photographing the magnetic groupings of iron filings as follows: I place a dry sensitised photographic plate over the magnet whose field I desire to fix, and after the characteristic groupings of filings have been obtained, I expose such plate, while over the magnet, to the light of a gas flame for a few seconds. This operation is necessarily performed in the dark photographic room. After exposure, the light is turned out, and only the non-actinic red or yellow light left. The filings are allowed to fall off the surface of the dry plate, and the finer particles that still adhere to it are brushed off by a feather or dry camel's hair brush. The plate is then developed and fixed in the usual manner. This process of obtaining records of magnetic fields produces true negatives, which, when employed for printing by blue print, silver print, platinotype, or similar process, produce excellent positives. As the negatives so obtained are more permanent than the positives obtained by the use of the filings themselves, they permit the taking of an indefinite number of photographic prints.

The Electric Light in Japan.—An association has recently been formed in Japan, to be known as the Nippon Electric Light Association.

Electric Lighting of Dundee.—It has been decided that the charge for the electric lighting is to be 5d. per unit. Mr. Urquhart (of Messrs. Urquhart and Small) reported at last Monday's meeting of the Gas Commissioners that he thought the work would be completed so as to enable the commissioners to supply the light in November. Powers for borrowing the necessary money have been obtained by the commissioners.

Blackening of Incandescent Lamp Bulbs.—A correspondent says that the writer of the note on lamp blackening in our last issue made a most unfortunate suggestion as to its possible cause. The notion of the "property of the black mercury sulphide when heated," and "quantities of material necessary to form the film," is absurd. The film is carbon to all intents and purposes; if mercury vapour does assist the transfer from the filament, it is as a vehicle.

Kingswood Electric Lighting.—At a recent meeting of the Kingswood Local Board, complaints were expressed by several members regarding the power of the electric light. The electric lighting company had been communicated with, and the reply received was that the limited power of the light was due to the lamps now being used. New ones had been ordered, which would greatly improve the light. The Works Committee intend inspecting the light at different stages throughout the electric lighting district.

Falmouth Exhibition.—The sixtieth annual exhibition of the Royal Cornwall Polytechnic Society was opened last week at Falmouth. There was a very interesting display of electrical appliances and accessories, amongst other exhibitors being Messrs. Benham & Froud, the General Electric Company, the Lithanode Company, Lund Bros. & Co., W. McGeoch & Co., and the Electrical Accessories Company. Western country interests were represented chiefly by Messrs. Veale & Co., Limited, of St. Austell; W. H. Perrow, of Truro, and W. J. Corse, of Plymouth.

Manchester Electric Lighting. — A *Manchester Examiner* correspondent, writing under the caption "More light," asks questions as to when the Manchester folks are to have the electric light. He has heard that a central station is being erected, and that the Corporation promised to be in a position to supply the current during August. He blames that body for the delay, and puts to them a host of queries as to whether or not the contracts have really been given out? If so, who has them? are they local firms or outsiders? if the latter, why should it be so? Have fair prices been accepted? Why have the particulars not been published? and so forth. The information asked will, of course, be very interesting when it comes to hand.

Recent German Researches.—At page 642 in *Wiedemann's Annalen* (1892, No. 8), there is the conclusion of an article by A. Toepler on the excitation and observation of very rapid electric oscillations, which will interest those of our readers who have been studying the researches of the last year or two on the oscillations of Hertz. There is a full description of the kind of apparatus employed by Toepler, and his method of interpreting the experimental results by means of curves. The researches of Sarasin and De la Rive are compared, and the acoustic analogy which we have several times alluded to in these pages, is well illustrated. Toepler's methods will be found very useful by those who are exploring this field of research. At page 666 there is a paper by A. Winkelmann, on the employment and working of telephones by the "null" method, which appears to put many mathematical points connected with this matter in a new light.

Theatre Electric Lighting.—The new Trafalgar Square Theatre is lighted throughout by electricity, but gas can be employed when needed.

Electric Light at Liverpool.—The Mersey Docks and Harbour Board have decided to accept a tender to establish a system of electric lighting at Wapping Dock warehouse.

Whitehaven Electric Lighting.—Enquiries are being made at Whitehaven by the local authorities as to the probable number of users, and the demand there will be for the electric lighting.

Portraiture.—Our contemporary, the *Machinery Market*, presents with the September issue a fairly executed ink-photo portrait of Mr. W. H. Preece. Although not quite so well printed as might be wished, the likeness is excellent. A brief account is also given of Mr. Preece's career.

The Reflection and Refraction of Light from a Magnetised Transparent Medium.—Those who are fond of mathematical exercises may find pleasure in studying a recent paper by Mr. A. B. Basset, who has been endeavouring to apply the theory of gyrostatically loaded media in the investigation of the reflection and refraction of light at the surface of a magnetised transparent medium. This has been already attempted by Mr. Larmor, who has, at least, obtained the equations of motion of the medium, but his paper left much to be desired. Mr. Basset states that when the magnetic force is parallel to the reflector, and also to the plane of incidence, the expressions for the amplitudes of the reflected light are the same as those which he obtained last year by means of an extension of the electro-magnetic theory. When the magnetic force, however, is perpendicular to the reflector these expressions, although of the same form as those furnished by the electro-magnetic theory, have the signs of the magnetic terms reversed. He endeavours to obtain a theoretical explanation of Kerr's experiments on reflection from a magnet, by combining the theory of gyrostatically loaded media with his theory of metallic reflection, but with unsatisfactory result. This, however, is not surprising, inasmuch as the theory of gyrostatically loaded media takes no account of the statical effects of magnetisation. But Mr. Basset's work is a valuable contribution, for all that, to the theories of magnetism.

Electrical Statistics in the United States.—Mr. Allen R. Foote, the special census agent in New York, has forwarded a letter to the New York *Electrical Engineer*, setting forth the advisability of collecting statistics anent the introduction of certain electrical inventions, and their development, in America. He also solicits suggestions as to the practicability of carrying out his proposals. The information he seeks he considers will be of great interest and value to those connected with the electrical industry. He asks persons *au courant* on such matters to advise him, giving full name and date as to "who first invented or used commercially in America continuous current, constant voltage and variable current dynamos, lamps, and motors; continuous current, variable voltage and constant current dynamos, lamps, and motors; alternating current, constant voltage and variable current dynamos, lamps, and motors; and alternating current, variable voltage and constant current dynamos, lamps, and motors; also trolley contacts, single or double." In addition to the above, official recognition should be given to those who first introduced the following engineering methods, and the date stated on which they were first commercially used in the United States:—Incandescent lamps; arc lamps, single carbon; arc lamps, double carbon; stationary motors: electric locomotives; converters and accumulators. A description is also desired of the first isolated and central station plants, and electric railroad. One of the chief objects in getting these particulars together is that due credit should be given to the inventors of the mentioned patents. These details, says Mr. Foote, are due to their successors, who are entitled to correct records, and the enterprise and skill of the American people also merit such a list.

Electric Lighting of Municipal Buildings at Dublin.—A Local Government Board enquiry was held at Dublin on Monday last, regarding applications made by the Corporation for new loans, amongst which figured the item, "for the supply of electric light fittings to the Corporation offices and fire brigade stations, £1,561 17s. 6d."

The Technical Press.—Our contemporary, the *Manufacturers' Engineering and Export Journal*, in its issue for August, describes the works of the Brush Electrical Engineering Company. The letter-press deals with the history and development of the company, the manufactures carried on at Belvedere Road, Lambeth, and at the Falcon Works, Loughborough; then follows an account of some of the notable contracts carried out by the company. Short biographical notices and portraits are given of the directors and engineers who have been more or less intimately connected with the Brush Company since its formation. It must of necessity follow that an account of the Brush Company is practically a history of the development of electric lighting in England; and, as such, is of value. Although electrical machines, such as the Mordey alternator, figure prominently in the illustrations, the Brush Company's productions now comprise many other manufactures, such as locomotives, pumps, and some of the London omnibuses bear witness that they have come from the Falcon Works. The printing of the *Manufacturer* is one of its strongest features, yet this month's issue is a tribute to English printing, photographic art, and engraving processes. The description comprises 19 pages of beautiful pictures, by the tone process, and 11 pages of matter.

NEW COMPANIES REGISTERED.

The Bilston Wire Company, Limited.—Capital, £50,000 in £100 shares. Objects: To acquire and carry on the trades or businesses of drawers and manufacturers of wire, wire rods, wire ropes, nails, steel converters, steel and iron manufacturers, &c. Signatories (with 1 share each): A. L. Hay, 20, Abchurch Lane, E.C.; Edward Cocherm, 20, Abchurch Lane, E.C.; Edward Alan Hay, 20, Abchurch Lane; T. J. Bevan, Osbaldeston Road, Stoke Newington; John Hill, West Smithfield, banker; Walter Townsend, 71, Cornhill, E.C.; Fred. James Townsend, 1, Dunster Court, Mincing Lane. The board shall consist of such number of directors as the shareholders shall from time to time determine in general meeting, and until such determination, and subject thereto, shall consist of not less than two, nor more than five; the first being Alex. S. Hall and Robert Page Dorman. Remuneration, £500 per annum; and, in addition, a sum equal to 5 per cent. upon the excess of net profits of the company for the year beyond the amount required to pay a dividend of 10 per cent. on the paid-up capital. Registered on the 26th ult. by G. M. Clements, 17, Gresham House, Old Broad Street.

Robert Dempster & Sons, Limited.—Capital £30,000 in £10 shares. Objects: To acquire the business of gas, chemical and hydraulic engineers, carried on by Robert Dempster & Sons, Limited (a company incorporated on August 2nd, 1887), at the Rose Mount Works, Elland, Yorkshire, and generally to carry on such business in all its various branches. Signatories (with 1 share each), Alexander Dempster, 6, Coleridge Street, Halifax, engineer; Albert Maitland Dempster, 6, Coleridge Street, Halifax, electrical engineer; C. T. Jacobs, Charles Street, Elland, cashier; Wm. Edgar Berry, The Hollies, Elland, draughtsman; Richard Henry Fletcher, 122, Huddersfield Road, Elland, boiler maker; Sherwood Tetley, 120, Huddersfield Road, Elland, pattern maker; Wm. Thos. Smith, 3, Rose Mount Terrace, Elland, ironfounder. The number of directors is not to be less than two, nor more than five, the first being elected by the persons subscribing to the memorandum and articles of association. Remuneration to be fixed by the shareholders in general meeting. Registered the 25th ult. by Thomas England, Halifax.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Allen Everitt & Sons, Limited.—The statutory return of this company, made up to the 5th ult., was filed on the 12th ult. The nominal capital is £300,000 divided into 10,000 preference and 20,000 ordinary shares of £10 each. The whole of the preference shares and 12,000 of the ordinary shares have been taken up, and £10 called on 6,700 preference shares and £8 on 8,000 of the ordinary shares. The full amounts have been paid, amounting to £131,000. Registered office, Adderley Street, Birmingham.

Lightning, Limited.—The statutory return of this company, made up to the 28th ult., was filed on the same day. The nominal capital is £3,000 divided into 2,400 ordinary and 600 founders' shares of £1 each. 1,703 of the ordinary and 512 of the founders' shares have been taken up. The full amounts of the calls have been paid, amounting to £1,915. Registered office, Faraday House, 8 and 10, Charing Cross Road, W.C.

The Ecuador Telephone Company, Limited.—The statutory return of this company, made up to the 1st ult., was filed on the 5th ult. The nominal capital is £100,000, in £5 shares; 5,000 of these have been taken up, and the full amount called, and all calls (£25,000) paid. Registered office, 53, New Broad Street, E.C.

BUSINESS NOTICES, &c.

Ernest Scott & Mountain.—Messrs. Ernest Scott and Mountain, Engineers, Newcastle-on-Tyne, have secured the contract from the Co-operative Wholesale Society, for a complete installation at their Waterloo Street and Thornton Street premises. The installation will be of considerable size and will consist of 3 compound wound dynamos fitted with heavy fly-wheels; each dynamo capable of easily running 400 16-C.P. lamps. There will be installed throughout the buildings between 700 or 800 incandescent lamps. The motive power for driving the dynamos is to be obtained from three of Messrs. Crossley Bros. 25 nominal Otto gas engines, each capable of giving 56 I.H.P. This installation is, perhaps, the largest in the kingdom where gas engines alone are employed as the motive power. In addition to this contract, Messrs. Scott & Mountain have in hand the lighting of the whole of the Ashington Colliery, and are also supplying a large installation to Messrs. Chadwick Bros. of Bolton, for the lighting of their mills in Russia. The firm are also supplying an electric pumping plant with engine, dynamo, motor and pumps, for the Newton Coal Company. This plant is designed to pump at its normal speed of 100 gallons of water per minute against a head of 80 feet, but will be capable of delivering double this quantity of water in case of emergency. We hear that the firm are also busy with installations for private houses, having in hand a large installation for Lord Ellesmere, at his house and training stables at Newmarket, and are also lighting Bonmore House, the residence of H. J. Younger, Esq., Argyllshire. Amongst local contracts may also be mentioned the lighting of Manor House, Newcastle-on-Tyne, the residence of James Knott, Esq.

The Ateliers Hoster de St. Nicolas, Limited.—The meeting of creditors and contributories under the winding up of this company was held on Wednesday, August 30th, Mr. Wheeler presiding. The company was registered on December 30th, 1890, and was formed to acquire the business of a mechanical and electrical engineer, carried on by Mr. Albert Hoster, at St. Nicolas d'Abervrout, in the Department of Seine-Inférieuse, France. The contract for the purchase of the business was never executed, owing, it was alleged by Mr. Hoster, to certain obligations of a private nature which he was compelled to discharge to enable him to sell to the company. 11, Queen Victoria Street is the registered office of the company, which, however, has never carried on any business. The unsecured debts amount to £190 2s. 4d., and the assets (consisting of unpaid calls) to £40. The failure is attributed to a judgment obtained against the company under Order 14, in default of bringing money into court as a condition for leave to defend. Only two creditors attended the meeting, and their proofs are the only ones to be made. One creditor for £115 suggested the appointment of the official receiver as liquidator. The other creditor required the appointment of Mr. Champness, accountant, of Coleman Street. In the result the case will have to be mentioned to the judge to decide as to who shall act, there not being a majority in favour of either. The contributories, at their meeting, appointed Champness as official liquidator.

New Premises.—The Edison & Swan United Electric Light Company have opened a City warehouse and order office at 110, Cannon Street, E.C.

The Electric Light in the City.—Since our last report further progress has been made with the adoption of electric lighting in the City. Among the new installations at present in hand are one in the premises known as The Baltic, Threadneedle Street, by the Brush Electrical Engineering Company, of Lambeth, one at Messrs. Salmon & Gluckstein's, Tobacconists, Walbrook, by Messrs. E. L. Berry, Harrison & Co., of Whitcomb Street, W.C., and one at the London offices, at 74, Cannon Street, of Messrs. Aveling & Porter, engineers, Rochester, by Messrs. John Pound & Co., of Leadenhall Street. Fitting work has also recently been carried out in the following premises:—Lloyd's Bank, Limited, 189, Fleet Street, E.C.; The American Tobacco Company, 58, Holborn Viaduct; "Ye Old White Horse" Hotel, Little Britain; Messrs. Maw, Son & Thompson, 7 to 12, Aldersgate Street; The "Falcon" Hotel, Aldersgate Street; The British and Foreign Marine Insurance Company, Cornhill; the London branch of the Manchester and Liverpool District Banking Company, Cornhill; The Liverpool, London & Globe Fire Office, Lombard Street; and Messrs. Benetfinck & Co., Cheapside.

Newspaper Folding by Electricity.—A copy of the *Birmingham Daily Gazette* has been sent to us after being printed, cut and folded by the aid of electricity. The proprietors of that paper placed an order with Messrs. Fowler, Lancaster & Co., of Birmingham, for a complete installation of electrical motive power to drive the whole of their machines. The contractors have put down two motors with all the necessary gearing for working the plant. The current is obtained from the Birmingham Electric Supply Company. On Thursday morning, last week, the first printing of an entire edition of two papers, the *Birmingham Daily Gazette* and the *Birmingham Weekly Mercury*, was done, the run being most successful. It is believed that this is the first daily paper in the country having dispensed entirely with steam and using electricity instead. There are two main printing machines in the establishment, which turn out altogether 20,000 papers per hour similar to the one we received, which we cannot help remarking is very cleanly printed and neatly folded.

The Electric Light in the West End.—There would appear to be no diminution of the growing popularity of electric lighting, compared with gas, in the West End, as since our last report we notice that a number of new installations are in hand. The Planet Electrical Engineering Company, Limited, of Westminster, are fitting up the residential chambers, situate at 23, Cork Street, W. —Messrs. W. A. S. Benson & Co. are fitting up the premises of Mr. F. B. Goodyer, at 155, New Bond Street.—Messrs. Lund Bros., who are engaged on the Guildhall installation, are fitting up their own offices at 355, Oxford Street, for electric lighting. — Messrs. A. Emanuel & Sons, of Marylebone, have recently completed an installation in the Horse & Groom Hotel, Oxford Street. — The new premises known as Willis's Rooms, in King Street, W., are approaching completion, and are being lighted throughout by electricity.

Electric Lighting in Cheshire.—An important electric light installation is being carried out at Peckforton Castle, the seat of Lord Tollemache, by Messrs. Barclay & Son, electrical engineers, of 138, Regent Street, London, under the superintendence of their engineer, Mr. Ardebut. An engine-house has been built near the entrance to the grounds, which contains a 40 horse-power Robey engine, of the locomotive type, which serves the double purpose of working a saw mill and the dynamo. The latter is a new type of dynamo, combining the advantage of two machines in one, known as the Scott-Sisling patent. It charges 56 E.P.S accumulators. The whole arrangement is on the same plan as the Model Country House installation, exhibited by the firm at the Crystal Palace Electrical Exhibition.

Tenders Wanted—Portsmouth.—Tenders are being invited for the erection of an electric lighting station in the Gunwharf Road, Portsmouth, for the Urban Sanitary Authority. The plans and specifications can be seen either at the Town Hall or at the offices of the engineers (Messrs. Waller & Manville, Albany Buildings, 39, Victoria Street, Westminster), on or after September 5th. The form of tender, specifications, and bill of quantities can be obtained on application to Mr. Alexander Hellard, town clerk, Town Hall, Portsmouth, on payment of five guineas, which will be returned on receipt of a *bonâ fide* tender. Applications for form of tender, specifications, and bill of quantities must be made at the Town Hall on or before September 7th. Tenders, on forms supplied, with the priced bills of quantities filled in and completed, to be delivered to the town clerk by 6 p.m. on September 26th.

Tenders Wanted—Bradford.—Tenders are invited for the construction and delivery of a steel Lancashire boiler, together with all steam, water, and blow-off pipes and fittings for the Bradford Electricity Works at Bolton Road, for the Corporation. Specifications may be inspected, and form of tender obtained, on application to Mr. Baynes, Electricity Department, Town Hall, Bradford. Sealed tenders, endorsed "Tender for Boiler," to be delivered at the office of Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by September 6th.

The Corporation, in connection with the extension of the electricity station in Bolton Road, require tenders for the supply and fixing of new roofs, floors, and other works. Plans may be seen, and specification and bills of quantities may be obtained, at the office of Mr. W. T. McGowen, town clerk, Town Hall, Bradford, or at that of Mr. J. N. Shoolbred, C.E., 13, Victoria Street, Westminster, S.W. Sealed tenders, endorsed "Tender—Electricity Works," must be delivered to the town clerk by September 7th.

Tenders Wanted—France.—The Administration of the Posts and Telegraphs, in Paris, is inviting tenders until September 8th, for the supply of 100 metrical tons of copper wire of high conductivity.

Country House Lighting.—Messrs. J. B. Saunders and Co., of Cardiff, have lately fitted up a complete installation of electric light for P. A. Vyoyan Robinson, Esq., at Valindia House, Whitchurch, near Cardiff. The prime motor is a 7 H.P. Priestman's oil engine which drives a 3,200 watt Phœnix shunt machine. The latter charges 42 E.P.S. Company's 15-L type accumulators and provides for a maximum requirement of 40 16-C.P. Edison-Swan lamps. 100 lamps (54 16-C.P. and 46 8-C.P.), are fitted up in the house, stables, coach houses, and other out-buildings.

Henley's Telegraph and Electric Construction Company, Limited.—A petition was presented on 23rd ult., by Mr. A. P. Matheson, a merchant, of 9, Cornhill, for the winding up of the above company. The hearing is to be by Mr. Justice Vaughan Williams on October 25th. The company was formed and registered four years ago for the purpose of taking over Henley's Telegraphs, Limited, but that contract was never completed, therefore the petition referred to has nothing whatever to do with the present W. T. Henley's Telegraph Works Company, Limited.

The Electric Light in the St. Pancras District.—The street lighting in this district is being gradually extended, but the number of new private installations in hand has somewhat fallen off. The large installation at Euston Hotel has been completed, and is now in working order.—Messrs. Rashleigh Phipps & Dawson, of Berners Street, W., have secured the contract for the installation in the premises, which are at present being rebuilt, of Messrs. James Elmy & Co., glass and china merchants, Tottenham Court Road.

G. Skudder & Co.—At the Laundry Exhibition held this week at the Central Hall, Holborn, one of the most prominent exhibits was that of Messrs. G. Skudder & Co., of Tooley Street, who showed a great variety of asbestos and India-rubber goods, leather belting, and engine-room requisites. Samples were also exhibited of the special boiler fluid with which the name of the firm is connected, and of a great variety of lubricating oils adapted for use on dynamos, gas engines, steam engines, and machinery of all kinds.

The Direct United States Cable Company, Limited.—We understand that, in order to afford greater facilities to the mercantile community in and around Mark Lane, having telegraphic intercourse with both of the Americas, a new station for the reception and delivery of trans-Atlantic telegrams was opened yesterday, September 1st, at 39, Mark Lane, E.C., which will be in direct communication with the company's trans-Atlantic cable system. This station will be open day and night, Sundays included.

A. Hall & Co.—Messrs. A. Hall & Co., of South John Street, Liverpool, have quite recently fitted up an electric light installation, consisting of 2 dynamo engines, and 40 incandescent lamps of 16 C.P., in the premises of a contractor in Elizabeth Street, Liverpool. Outside the building the thoroughfare is illuminated by a handsome 15 ampère arc lamp of 3,000 C.P. The same engines also work a 10 ton hoist.

Electric Lighting of the Conservative Club.—This palatial house in St. James's Street is to be fitted throughout the whole of the member's portion, with the electric light. About 400 incandescent lamps will be employed. Tenders for the installation have been obtained to the specification of Mr. A. A. C. Swinton, who is acting on behalf of the committee as consulting engineer.

Rashleigh Phipps & Dawson.—Messrs. Rashleigh Phipps & Dawson have secured the contract for the electric lighting fittings at the Junior Constitutional Club. They have carried out some special designs for this work, which are said to be some of the prettiest and most original electric light fittings in London.

The Coventry Dynamo.—The Coventry Electrical Engineering Company, formerly Messrs. Stafford & Eaves, have removed into larger premises more centrally situated. They have also taken into partnership Mr. W. J. Butlin, a gentleman of considerable experience in American electrical practice.

Personal.—We understand that Mr. Joseph A. Jechell, who has been connected with the cable department of the London Electric Supply Corporation, Limited, for the last four years, has been appointed electrician to the International Okonite Company.

Change of Address.—Mr. A. H. Wood, of Chesterfield House, Great Tower Street, E.C., informs us that on and after the 7th inst. his address will be Albany Mansions, 39, Victoria Street, S.W., where he will open more convenient offices.

CITY NOTES.

City of London Electric Lighting Company, Limited.

THE second annual general meeting of this company was held yesterday (Thursday) at Winchester House, Old Broad Street, E.C., Sir David Salomons, Bart., chairman, presiding.

Mr. J. CECIL BULL, the secretary, having read the notice convening the meeting,

The CHAIRMAN said he would continue the history of the company from the point at which he left off when the board last met the shareholders. At that time applications for shares had been received to the amount of £300,000, which they considered very good, considering that times were very bad just then; £100,000 worth of shares then remained, and these had now been applied for, and would soon be employed on the company's works. It was further intended, within a very short time, to issue the preference stock. The intention at present was to issue half the preference stock, £200,000, at 6 per cent., and to give the shareholders the first chance of obtaining it. He thought, not to speak too openly, that within twelve months they would be in a position to pay a dividend to the ordinary shareholders. Matters were now beginning to mend; the stations were now working, not at a loss, but at a small profit, and as the machinery was put in and run at full load, the money would come in, and nearly every penny would go to profit. After referring to the arc lighting in the City streets, and remarking that the work, both that which was visible above ground and that underground, was thoroughly well done, the chairman drew attention to curves hanging on the walls of the hall, stating that these illustrated the incidence of expenditure and receipts, and pointed out that whilst for some period in the beginning of the company's operations the expenditure had greatly exceeded the receipts, the reverse was now the case, and they might safely assume that the excess of receipts over expenditure would now rapidly increase. By the spring of 1893 it was anticipated that their stations would be able to supply 78,000 8-C.P. incandescent lamps, in addition to the 700 arc lamps which they could now supply. When they considered what a trying winter the last was, and that the company had been so recently started, he thought they would agree that what they had put down beat all previous records for the time. The gross earnings exceeded £20,000 a year, and this would increase continuously. The machines which had been laid down had been found to yield 10 per cent. in excess of the capacity contracted for, a fact which was highly creditable to the contractors, and very satisfactory to the company. As regarded the rate at which the work had proceeded, as much as 30 miles of tubing had been put down in a week, and the average for the year was 10 miles per week. The contracts with the City required that 47,072 yards of trenches should be made in the main streets, and of this 45,410 yards had already been laid, leaving only 1,662 yards to complete, and this would be done in the course of the next two or three weeks; and an additional 49,412 yards had been laid in lesser streets, where it was not compulsory. Altogether, about 303 miles of ways had been laid. The length of cables drawn in was about 63¼ miles of high tension, and 22 miles of low tension. There were 334 arc lamps already lighting the streets of the City, and by the middle of September, the full number required by the contract, with the exception of a few which they were unable to put up in consequence of building operations and contemplated reconstruction of refuges, would be running. Up to June 30th, 11,860 8-C.P. glow lamps were running on 6,735 yards of main, which gave for each yard of main a density of two lamps. If this proportion were to hold throughout the district where the streets were all ready for mains, it would give 100,000 8-C.P. lamps. In Lombard Street the lamp density was as high as six lamps per yard of main, and in Cornhill it was nearly as much. In conclusion, the Chairman moved the adoption of the report and accounts.

Mr. PURCELL, a shareholder, seconded, and the motion was carried.

Messrs. W. H. Pannell & Co. were re-elected auditors, at a remuneration of 100 guineas, and the proceedings terminated with a vote of thanks to the chairman and other directors.

New Zealand Electrical Syndicate, Limited.—The directors of the New Zealand Electrical Syndicate (of which the authorised capital is £100,000 in £10 shares), announce the issue of £20,000 in 2,000 £10 shares. This amount will make, with £20,000 reserved for vendors and £10,000 already subscribed, an issue of £50,000 for completing the lighting of the city of Wellington, New Zealand. A further issue is to be made next year for the lighting of the city of Christchurch, New Zealand, which will be carried out in the year 1893. The prospectus states that the income derived from contracts there mentioned, at present amount to £1,917 per annum, but there is every prospect of more lamps being required by the Wellington Corporation which will increase the gross income to £2,800 per annum, and adding, at least, £500 per annum to the net income of the syndicate. The price of gas in Wellington is 9s. 5d. per thousand cubic feet, less 25 per cent. discount for cash, and there is no probability, or even feasibility, of that figure being reduced; therefore the price of 10d. per unit for electric lighting will compare somewhat favourably. A letter from Mr. D. De Castro, chairman of the Gülcher (New) Electric Light and Power Company, Limited, accompanies the prospectus in which he refers to the success attending his recent journey to Australia and New Zealand. He states that the lighting of Wellington is more than two-thirds done and can be completed within four or five months. He considers the remarks in the prospectus, regarding the outlook in New Zealand, underrated.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 28th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £3,283.

The City and South London Railway Company. The receipts for the week ending August 26th, 1892, amounted to £805; corresponding month, 1891, £717, increase £88; total receipts to date for half-year, £6,953; corresponding period, 1891, £6,397; increase £556

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, August 25th.	Closing Quotation September 1st.	Business done during week ending September 1st, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100—103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47 — 48	47½— 48¼	...	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88½	88 — 89	88⅞	87⅞
2,849,510*l*	Do. do. Deferred	Stock	10⅛— 10⅜	10⅛— 10⅜	10⅜	10 5/16
130,000	Brazilian Submarine Telegraph, Limited	10	10⅜— 11¼	10⅜— 11¼	11¼	11
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞— 3⅛	3¼— 3½	3¼	3 3/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2¼— 2½	2⅜	2¼
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3⅛xd	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	9⅜— 10½	10 — 10½	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	160 —165	160 —165	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	1/4— 3/8	1/4— 3/8	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼— 5⅜xd	5¼— 5⅜	5 1/16	...
16,000	Cuba Telegraph, Limited	10	11 — 12	10½— 11½xd	...	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17 — 18xd	18¼	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜— 11⅝xd	11⅜— 11⅝	11⅝	11¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14⅞— 15⅛	15	14 13/16
70,000	Do. 6 p. c. Preference	10	15½— 16	15⅛— 16	15⅞	15⅛
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	108¼	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	110 —113	112	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15⅜	15 1/16
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	104½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	109½	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4⅜— 5¼	5 — 5⅛	5	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	7/8— 1⅛	¾— 1	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2⅜— 2⅝	2⅝	2⅛
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛— 1⅜	1⅛— 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10¼— 10⅜	10¼— 10⅜	10⅜	10 5/16
180,042	Do. do. 6 p. c. Preference	10	15⅛— 15⅞	15⅜— 15⅝	15⅝	15 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	107 —110	105 —108xd	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	5½— 6½	5½— 6½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½— 22½	21½— 22½	22½	21⅜
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	42 — 44	43¼	42⅜
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	3½	...
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	105 —108xd	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅞— 7¼	6⅞— 7¼	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 5	5	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¾— 14¼	13¾— 14¼	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13 — 13½	13 — 13½	13½	13¼
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 —111	109 —111	110¼	...
250,000*l*	Do. (issued at 5 p.m., all paid)	...	109 —111	109 —111	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½— 8	7½— 8	7¾	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	116 —121	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3¼	3½— 4	3⅝	3⅜
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43¼	42¼
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½— 7⅜	6½— 7⅜	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	101 —104	99 —102xd	103½	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8⅜— 9¼	8⅜— 9¼	...	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6 1/16	...
30,364	Do. do. do. 5 p. c. Deferred	7½	2⅜— 3¼	2⅜— 3¼	3	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 -106	103 —106	104½	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1⅝	1 3/16	1½
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼— 9½	9¼— 9⅜	9⅜	9⅛
4,669	Do. do do. do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	101 —105	101 —105	101½	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	123 —128	123 —128	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	97 —102xd	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼xd	5⅜— 6¼	...	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6¼—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20¼.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2¼—3¼.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid, 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2¼—3.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892)

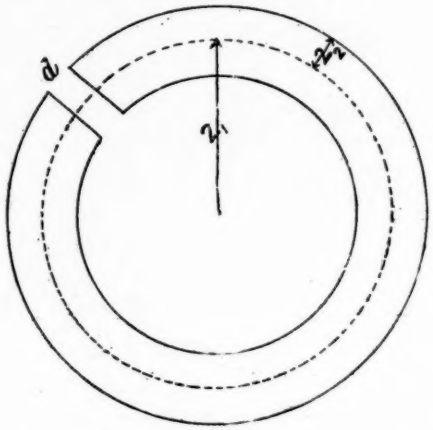
THE BRITISH ASSOCIATION.

ON LEAKY MAGNETIC CIRCUITS.

By Dr. H. E. J. G. Du Bois.

(*Read before Section A, August 5th*, 1892.)

EVER since the Hopkinsons' researches a great many experiments on magnetic circuits have been made; mostly, however, in the form of measurements on dynamos of various types. Now the results obtained with a particular dynamo may offer a certain degree of interest, especially to its maker; but the utmost care has to be taken in generalising from such data. Quite apart from the consideration that ballistic measurements on dynamos suffer under the undue proportion their time-constant bears to the period of even the slowest ballistic galvanometer, dynamo circuits are not designed for giving interpretable scientific results, but for economy. For all those reasons it seemed to me a useful thing to thoroughly overhaul the whole subject by theorising and experimenting on the simplest conceivable type of magnetic circuit, and though the subject of these circuits has been amply discussed for the last 10 years, I venture to hope that its importance may warrant my bringing the first results of this rather lengthy investigation before Section A.



Consider a split ring, magnetised by a uniform peripherical field. Let r_1 be the radius of the central circle, r_2 that of the circular section, d the width of the air gap. Assuming, then, as a first approximation that the magnetisation is uniform over the whole section of the ring and its direction everywhere peripherical, it may be shown* that

$$\mathsf{N} = \frac{2\,(d + r_2 - \sqrt{d^2 + r_2^2})}{r_1 - \frac{d}{2\,\pi}} \qquad (1)$$

where N is the well-known "demagnetising" factor which determines the amount of shearing over of the magnetic curves.

According to a theorem first enunciated by Kirchhoff, the above state of affairs will strictly occur when the external magnetising field becomes infinite; the direction of the lines of magnetisation is then bound to coincide with that of the applied lines of force. The values of N actually found must therefore approximate to those given by (1) as the field increases.

For weaker fields an exact calculation is impossible, but it may be stated that in this case

$$\mathsf{N} = \frac{2\,d\,n\left(\frac{d}{r_2}\right)}{r_1 - \frac{d}{2\,\pi}} \qquad (2)$$

where the functional notation $n\left(\frac{d}{r_2}\right)$ means a number which is a function only of the ratio of width to radius of air-gap, independently of the rest of the circuit. This number, n, is practically equal to the reciprocal of the leakage coefficient as defined by the Hopkinsons.

It may be remarked that both the expressions given converge towards the simple form

$$\mathsf{N} = \frac{2\,d}{r_1} \qquad (3)$$

when the width of the air-gap diminishes more and more towards zero. In this case the value of n is unity, whereas for wider gaps n becomes a fraction. Moreover, the number n, as well as the factor N, vary somewhat with the magnetisation in a way which it must be left to experiments to determine.

These were carried out, under my advice, by Mr. H. Lehmann. A ring, about 15 cm. mean diameter and 2 cm. thick, was turned out of best Swedish plate and well annealed. It was wound uniformly all round with primary and secondary wire, and its normal curve first taken in the unsplit state. It may be remarked that curves of ascending reversals were taken throughout, the thickness of the iron giving so much time-lag that the step-by-step process would not give correct results. The magnetising field could be pushed to 400 C.G.S., the ring being immersed in a trough of iced petroleum.

The ring was now cut, beginning with a very narrow gap of a few tenths of a millimetre width. A small brass disc was fixed in the gap to prevent the iron from yielding to magnetic attraction, and a small secondary wound so as just to enclose the lines of induction crossing the air. Another auxiliary secondary coil could be moved around the ring so as to explore the leakage.

The general results may be summarised as follows:—

1. For the very narrowest gaps the formula (3) holds, as it should.

2. As the width increases (2) becomes applicable; the values of n found from the throw due to the auxiliary secondaries, when substituted into (2), give numbers for N in good agreement with those found by the "shearing backwards" graphical process.

3. Both n and N remain practically constant up to values of I, about half the "saturation" value—*i.e.*, 850 C.G.S.; for higher magnetisations they begin to show an *increase*, N approaching to but not superseding the value given by (1), as was theoretically predicted above.

4. As a rule the *mean* magnetisation was deduced from the throw due to the principal all-round secondary; this was almost identical with the result given by the auxiliary secondary when diametrically opposite the air gap. And by further exploration with this secondary it was found that an appreciable leakage began to occur only at about one-eighth of the circumference on both sides of the gap.

The numerical values of n within its range of constancy (which is the range of magnetisation mostly worked with) are of general interest, because they, or their reciprocals, depend only upon the ratio of width to radius of air-gap, as explained above. Moreover, it will hardly matter much whether the section of the gap be exactly circular so long as its area be the same; we thus obtain numbers of a certain utility in all questions of design where air-gaps occur. I prefer not to give the actual figures here, they being liable to slight corrections; they will soon be published in full in *Wiedemann's Annalen*, together with the experimental detail.

The result 3 that n finally *increases* with I, I consider to be fully proved by experiment; it corresponds to a final *decrease* of its reciprocal, the leakage coefficient. Now this is in complete disagreement with what is generally accepted as a dogma, viz., that leakage becomes more and more pronounced with larger inductions. This fallacy, as I cannot now help calling it, has generally been explained by the fact that the permeability of iron decreases, and so becomes more equal to that of the surrounding medium. If then Ohm's law held, there is no doubt but that more leakage would occur. But a true ohmic law does not hold in magnetism; or rather, the excellent results obtained by applying it in particular cases do not warrant its generalisation. Its complete failure to predict or explain in the present typical case may be hoped to bring home a little more care in its manipulation to those liable to grow too enthusiastic about magnetomotive force and reluctance.

On the other hand, physical theory is quite competent to explain the final decrease of leakage, which experiment has demonstrated to occur in the split-ring uniformly magnetised. For Kirchhoff's theorem, already alluded to, in connection with the tangent law for the "refraction" of lines of induction at bounding surfaces, clearly shows that those lines will tend to become more and more exactly peripherical as the applied field is being pushed up, thus diminishing the number of lines leaking away into the air.

In conclusion, it may be remarked that it is quite possible that leakage may yet increase in particular forms of circuits where the magnetising field is not uniform all round, *i.e.*, where coils are arranged in some haphazard way, more especially so if there be no coils near the gaps. It has to be borne in mind that on increasing the current in such coils, the strong field so applied will finally overpower the self-demagnetising tendencies altogether, and arrange the lines of induction after its own fashion. Of course, exactly the reverse happens when weak fields are applied. I intend shortly to investigate this subject a little further, by means of a large sized ring electro-magnet, with 12 separate coils, made from my designs by Messrs. Siemens and Halske.

* See "Mathematical Theory of Ferro-magnetism," *Wied. Ann.*, xlvi., p. 494, 1892.

ON A MAGNETIC BALANCE AND ITS PRACTICAL USE.

By Dr. H. E. J. G. Du Bois.

(*Read before Section A, August 9th*, 1892.)

IN a paper on "Magnetic Circuits and their Measurement," read to the Frankfort Electrical Congress in 1891 *, the principles of a magnetic balance were explained, with which magnetic curves of any material might be readily obtained in absolute measure. Theoretically, it may best be defined as an electro-magnetic system of variable configuration, the reluctance of which always naturally tends towards a minimum; the variations, however, remaining exceedingly small. I now propose to describe the instrument exhibited to the section; it is the outcome of a year's evolution of constructive detail. By means of a gauge belonging to the instrument, one test-piece, T, is cut to 15 cm. length and 1·128 cm. diameter, corresponding to 1 cm.^{2} section; the latter need not necessarily be adhered to if inconvenient, but has the advantage of obviating all further calculations, as will be seen below.

The coil, C, is 4 π cm. long †, and wound with 100 turns; therefore near the middle it gives a field = 10 × current (in amps.). It will carry currents up to 30 ampères, which may be conveniently mea-

* The *Electrician*, Vol. xxvii., p. 634, 1891.)

† Really it is slightly shorter (12·2 cm.) to compensate the end effect.

sured by the usual ampèremeters; the corresponding range of field (0 to 300 C.G.S.) is all that is required in the great majority of cases. The test-piece is supported on two adjustable M-plates, by means of which it may be readily set concentric to the coil, which is then slipped into position, the test-piece being automatically clamped by the plunger in the upright, v_2. Fig. 1 is a cut (one-quarter of the natural size) showing the curved yoke,

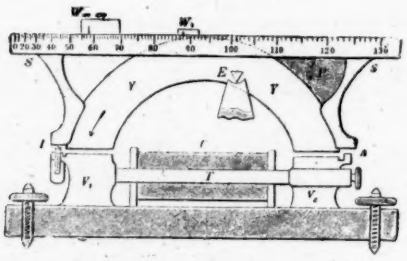


FIG. 1.—DIAGRAMMATIC VIEW.

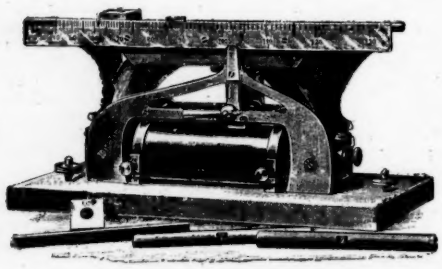
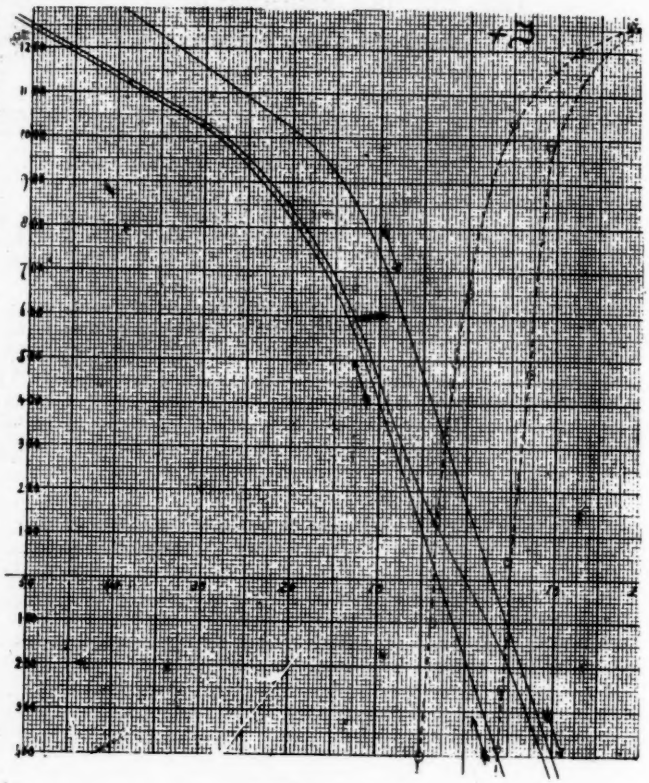
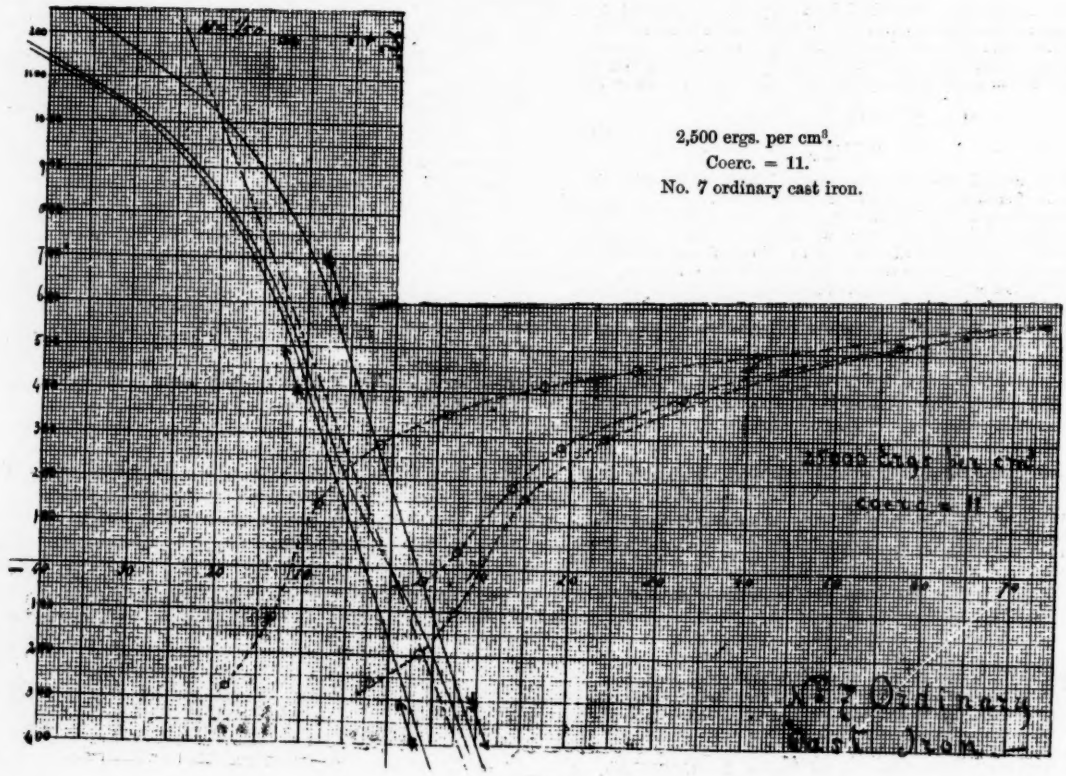


FIG. 2.—PERSPECTIVE VIEW.

Y, Y, of best Swedish iron playing over the stop, A, and screw, I. The latter is enclosed in a cap after calibration, so that the adjustment cannot be interfered with. P is a lead counterweight. Fig. 2 gives a perspective view of the instrument.



20,000 ergs. per cm².
Coerc. = 4.
No. 9 iron wire (annealed).
FIG 5.



2,500 ergs. per cm².
Coerc. = 11.
No. 7 ordinary cast iron.

FIG. 3.

I have made a series of observations to find experimentally what function of the magnetisation of the test-piece the resulting moment on the yoke (measured by compensating with the sliding weights) would prove to be. A small secondary was slipped over the middle of T, and connected to a ballistic galvanometer. It was found that the resulting moment was accurately proportional to I^2 (or B^2 up) to values of $I = 1{,}300$ (or $B = 16{,}000$), with a test-piece of 1 cm.² section; this is all the range that is usually required; however, by using a somewhat thinner sample, magnetisations up to 1,700 C.G.S. may be measured, as the tractive forces really depend upon the flux of induction through the test-piece only.

After this law had been experimentally established, it was evidently

better to introduce a quadratic scale, along which two mutually independent weights, w_{100} and w_4, slide, of 100 and 4 grammes weight respectively. Accordingly the scale-readings have only to be multiplied into the square roots of those weights—viz., 10 or 2—in order to obtain the absolute value of $|$ in the sample. The smaller weight is used for the range $0 < | < 260$. It is then slid back to zero and measurements continued with the larger weight for $260 < | < 1{,}300$. The instrument does not indicate whether one is to take $+\sqrt{|^2}$ or $-\sqrt{|^2}$; but on plotting the results this becomes at once evident, one of the two points falling entirely outside the smooth curve joining the observations. It is therefore unnecessary to add a special permanently polarised arrangement with which to detect the direction of magnetisation.

The demagnetising factor, N, for a cylinder of dimensional ratio (length/diameter) 15 is about 0·12).* It is found in the balance to be reduced to 0·02, corresponding to the threefold ratio 45. This number was found by plotting the curve of a standard sample directly from the balance and shearing it backwards into coincidence with the normal curve obtained with a ring of the same material.

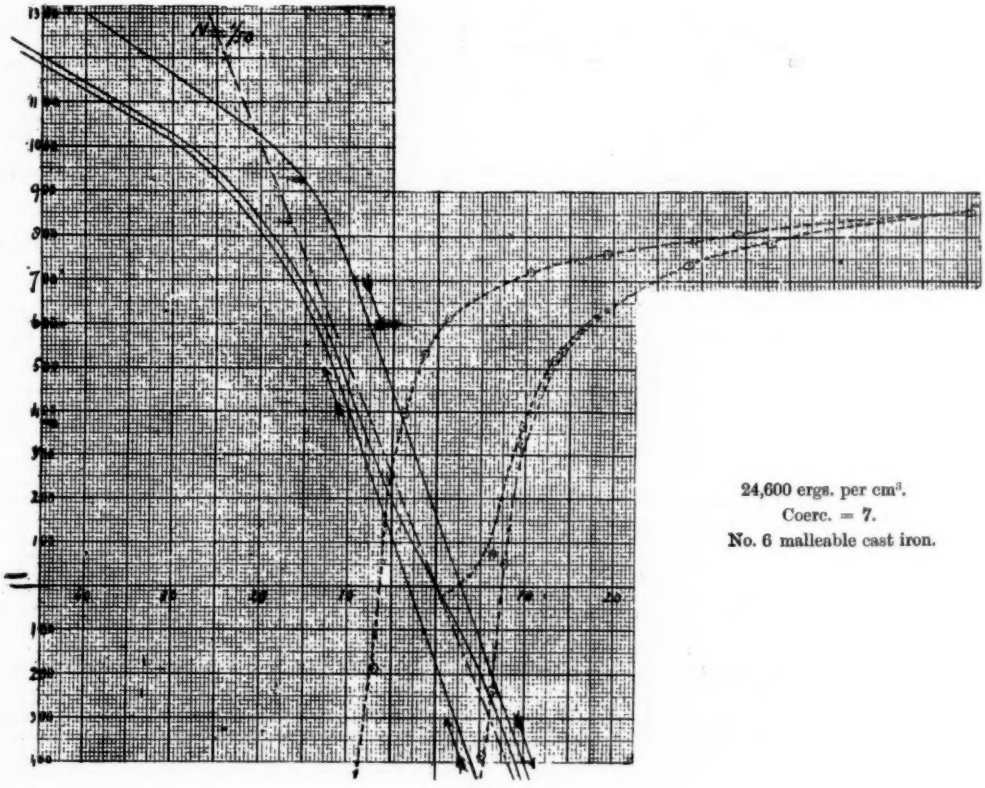
The result was, moreover, arrived at, that the usual rectilinear pseudo-axis of ordinates would do well enough up to half the saturation value, but that on the whole it was more accurate to introduce a generalised curvilinear shearing base. This may be called an instrumental directrix, as it remains characteristic of the instrument when once determined by means of a standard sample; all the corrections due to the uprights, v_1 and v_2, the yoke, Y, Y, the air spaces with their variable leakage, &c., are contained in it; it is used when ordinary unlooped curves of ascending reversals are being taken. In order also to correct for hysteresis of instrumental parts of the magnetic circuit, it is advisable to introduce two other directrices, the horizontal distance of which measures the coercive force of the apparatus. The left one is used for plotting ascending curves, the right one for the descending branches.

In conclusion, I may offer a few remarks on the practical use of the magnetic balance. The coil is placed in circuit with a reversing key, a good ampèremeter, one or two storage cells, and rheostats (preferably liquid) so as to admit of easily and gradually reversing, varying and reading the current between 0 and 30 ampères. In the first place, everything should be thoroughly demagnetised by diminishing reversals; accordingly, the yoke is slowly lifted by an arrangement provided for the purpose, while the reversing key is being quickly worked; it ought to remain in the lifted position when the instrument is not used, in order to spare the knife-edges, E. Then the coil is moved towards the observer and the test-piece gradually pulled out, reversing all the time.

The method of taking readings will be sufficiently obvious from the above description. I will only add that, on account of magnetic instability, the position of the sliding weight is determined, which will just pull the left-hand stop off the screw, I. It has been found an unnecessary complication to introduce a secondary bell or telephone circuit as a criterion for the breaking of contact. The observer's ears and fingers afford a readier means, and after some little practice, different observers always find exactly the same reading to one or two-tenths of a scale division (corresponding to a unit of magnetisation); this is more than sufficiently accurate.

The tenfold ampère and scale readings (or with the small weight, only double the latter) directly give abscissæ and ordinates respectively in C.G.S. units. The former are measured from the instrumental directrices, as explained above; these are drawn on a transparent card belonging to the instrument, which is laid on the upper left-hand or lower right-hand quadrant of the squared paper, the plotting on which is thereby rendered as simple as when the usual method is followed. If the section of the test-piece is not 1 cm.², it has to be measured, and the ordinates have still to be divided by it *after* the above process of plotting.

The dotted curves of figs. 3, 4, and 5 were obtained with actual samples in the instrument exhibited. The full drawn lines are the directrices; the middle one for ascending reversals is seen to considerably deviate from the straight line corresponding to $N = 0{\cdot}02$ as the magnetisation increases beyond 850. From the malleable iron curve, fig. 4, the first given for this material, so far as I am aware, it may be inferred that its magnetisation (for $H = 65$) is about 50 per cent. greater, and its coercive force as much less than those of ordinary cast-iron. Fig. 5 was obtained with a bundle of 124 thin iron wires, representing a total cross-section of 1 cm.².



24,600 ergs. per cm³.
Coerc. = 7.
No. 6 malleable cast iron.

FIG. 4.

* See the table in my "Mathematical Theory of Ferro-magnetism," *Wied. Ann.*, xliv., p. 498, 1892.

PRIMARY AND SECONDARY CELLS IN WHICH THE ELECTROLYTE IS A GAS.

By the PRESIDENT, Prof. SCHUSTER.

(*Read before Section A, August 5th.*)

IT is well known when you have a discharge passing through a tube, the tube thereby becomes a conductor, and you can send a current in any other part of the tube from a Daniell or any other cell through. It seemed to the author that it would be of interest to study the laws of that conduction which he would like to call secondary conduction in gases, because we are evidently having a more simple phenomena than in the other. For this purpose I have a tube with electrodes, then in some other part of the tube there is introduced platinum wires which are connected to ordinary batteries. While refraining from entering into the principles of the laws of secondary discharge, there is one point which is of interest on the theory started by different physicists, that the primary phenomena of discharge depends upon the dissociation of molecules, we have never yet found effects of polarisation similar to that when water is being decomposed in gases. Attempts have been made to explain why such phenomena could not happen in gases. We have looked very carefully for that phenomena of polarisation in this secondary conduction. When we got hydrogen in the tube there was no trace of polarisation with aqueous vapour or hydrochloric acid, or with a

number of combined gases there was only a trace of polarisation, but as soon as we introduced hydro-carbon or some particular gas in the gas, then you at once got very marked phenomena of polarisation. Start first with platinum electrodes, send a current through the secondary electrodes from a battery of ten or twenty cells, and you get a steady current which can be measured with a galvanometer, as soon as you introduce this gas; then break the current and connect the electrodes with a galvanometer or electrometer; then you get 4 or 5 volts back E.M.F. from these cells, and the way in which the effect falls off is exactly that in which it falls off in water; the law of tracing out polarisation effect is exactly the same; of course the resistance in the air is enormous, so that the currents are very small. We found the safest way was working with electrometers, with proper precautions. The falling off, so far, seems to point necessarily to some work done by the current of the nature of electrolysis, but when we introduced other electrodes, we found that the effect depended to an enormous degree on the nature of the metal which forms the electrode. With copper or iron we hardly get any effect, and that may be in itself a proof of the reality of the phenomena. In tubes after tubes, with different kinds of hydrocarbons, whatever the platinum was in itself, we got certain E.M.Fs. which we proved to be independent of a number of other circumstances, such as gas. But while with copper or iron we only got very small effects of polarisation, with magnesium the effects of polarisation increased to an enormous extent. I am almost afraid to give the number, but with magnesium electrodes after currents had been passed for a long time, so that the changes appear to take place and become permanent, we got a back E.M.F. of 35 volts from a single cell. That shows it is not an ordinary effect of the gas decomposition. but that it is an effect which may be similar to that of the secondary cells, and that is what I call these effects of secondary cells. The magnesium electrodes which were used in these experiments, both a positive and negative, have on them a deposit, which appears to be a finely divided surface of carbon, which is deposited by the discharge on the magnesium, which probably forms a loose compound with the magnesium. The gas under the influence of primary discharge is able to act as an electrolyte, in so far as the primary cells are concerned. Prof. Arrhenius has been working independently of me in the same line. His experiment was arranged a little different; he introduced plates or wires of zinc or platinum, simply connecting them to the galvanometer. The results obtained from these experiments have been already described by Prof. Arrhenius.

ON ELECTRICAL DISCHARGES.

By Prof. E. CH. WIEDEMANN and Dr. EBBT.

(*Read before Section A, August 5th.*)

THE object of the experiments to be described was to study the phenomena in rarefied gases under the influence of electrical oscillations of a definite period, to get a deeper insight into the nature of discharges. The authors adopted the method of Leiher, only they substituted for the induction coil a Töpler machine with 20 rotating plates, purchased out of a grant given by the Elizabeth Thompson fund. The Leiher wires were between 6 inches and 14 inches long. Bridges could be put over them at the places of the nodes, or anywhere else. The ends of the cores were connected with the plates of a Kohlrausch condenser—"the air condenser." As other experimenters, they found that there was a great difficulty, often impossibility, in getting a luminosity of the tube if it was of small diameter. Larger tubes were much more easily excited. We found that not too small tubes, with inside coatings of platinum, always gave luminosity, and that if these were brought near other insensible tubes these also began to shine, and even did so after the exciting tube had been removed. The phenomena are described which occurred in different tubes and in different positions of the tube, especially curious dark spaces in the evacuated tube in the neighbourhood of the condenser plates, through which the oscillations passed unabsorbed; some cases were discussed in which the discharges ceased by increased evacuation.

ON THE PHYSICS OF THE VOLTAIC ARC.

By Prof. SILVANUS THOMPSON, F.R.S.

(*Read before Section A, August*, 1892.)

THE author said if one measured with a voltmeter the difference of potential between the two electrodes of the arc, you find, when the arc is steady, the total voltage so observed is something over 40 volts, and it is known that part of this varies with the length of the arc and the current sent through the arc, and that part is practically independent of either the current or the length. There is a constant part and another part, which varies nearly directly as the length of the arc when the current is constant, and nearly inversely as the current when the length of the arc is constant. A useful approximate formula for the steady arc is $v = a + b\frac{l}{i}$, where a and b are constants, l the length of the arc, and i the current. The constant a varies between 35 and 39 volts; whilst when l is given in millimetres and i in ampères the constant b has values between 8 and 18.

Now, this constant part of the voltage, which is independent of the strength of the current for an invariable length, and independent of the length of the arc for an invariable current, is sometimes called the apparent back electromotive force of the arc. The arc acts as though it were the seat of a back electromotive force. I am not saying there is actually one, only that it acts as though there were. It is possible to account for the thing equally well by saying that there is somewhere in the arc a resistance which proportions itself always inversely to the current. Now, how can any resistance proportion itself so to the current? It can only do so in the following way:—If there is at any one surface of the arc a something equivalent to a transition resistance, then if that varies inversely with the area over which it takes place, and if the area over which it takes place is proportional to the current, then you might have something of the kind to explain this. Some years ago I explored the question of the seat of this supposed back electromotive force, and established, by means of the measurements made with a third movable electrode, that the seat of this electromotive force was at the crater. This was when taking the ordinary method of producing the arc between two carbon electrodes, an upper and a lower. I explored where the great drop of potential, 35 to 39 volts, occurred. I found that the drop of potential along the arc only amounted to a few volts, and where the great drop took place was at the surface of the positive electrode or crater. This is where most of the work of the arc is done. That being settled as to position, the next question was, what was the physical process going on there which would require such absorption of energy which made this great fall of voltage, and I could only account for it at the time by supposing that the volatilisation of the carbon required it. I was led to this by various reasons, one being Captain Abney's discovery that the surface of the crater is always of an equal intensity; the brilliancy for the same quality of carbon per square centimetre was always the same. I was led by that to think it must be simply a question of volatilisation.

Quite recently, however, Mr. Crookes has made the observation that the flaming discharges produced by alternating electric currents at very high rates of alternation and very high voltage, are really endothermic flames of nitrogen and oxygen; in other words, those flaming discharges are simply flames which, instead of giving out heat, absorb heat. Now, in the voltaic arc, as produced in air, something of this kind may occur. There must be a temperature high enough to bring about for the time being the combination of nitrogen and oxygen. We know from Prof. Dewar that such combinations are going on. The question consequently occurred to me whether this had anything to do with the voltage of the arc; and within the last month I have made a number of experiments to put this particular point to the test. A number of experiments were made in my laboratory to test whether the possible combustion of nitrogen and oxygen together had anything to do with the electromotive forces there observed. We did this by surrounding the arc by a glass tube, into which we could introduce a number of gases, say oxygen, nitrogen, carbonic di-oxide, hydrogen, and so forth. Using always short arcs, and waiting until the current was adjusted to 10 ampères and the arc adjusted to the exact length, we found it does not really make one volt difference. The back electromotive force, or whatever it is, is independent of the surrounding atmosphere.

Incidentally we have observed several effects, namely, that when chlorine and carbonic oxide are used as the atmosphere in which to produce the arc, the crater takes a quite different form from that of the usual arc. The carbon is flattened over the end instead of hollowed, and the negative carbon is also a very obtuse cone. Also when the arc is made with hydro-carbon or coal gas around it the crater is formed, but the edges do not burn away as they do when the arc is made in air. Consequently, there is a regular sooty deposit all round, and the arc is formed up inside a sort of cage. When the arc is made in oxygen, both the carbons burn away very fast. Instead of their ordinary consumption there is an extraordinary consumption which burns them down conically a long way. We have also observed in bringing these gases to the outside of the arc, it is necessary that they be introduced gently, without violent draughts, because with even a gentle current of gas the voltage is altered. By blowing on an ordinary arc in air the voltage has been made to rise to as much as 75 volts.

The experiments were conducted by Mr. Eustace Thomas, one of the demonstrators, and by Mr. Portheim, one of my students, to both of whom my thanks are given. There still remains much to do in measuring with exactitude the small variations which may be due to endothermic actions.

MOTORS USED FOR FOG SIGNALS IN THE NORTHERN LIGHTHOUSE SERVICE.

By Mr. D. A. STEVENSON, M.I.C.E.

(*Read before Section G, August 9th.*)

THE author dwelt upon the necessity of a means of signalling on the coast line during foggy weather, and enforced his statement by details as to the duration of fog in this country. It appeared that the number of hours in Scotland is 395 per annum. The most powerful sound signal in use is the siren, actuated by compressed air. The author described the various motors used for the purpose. The sources of power are motion of the sea by waves and tide, manual labour, clockwork, steam, hot-air, gas, and oil engines. After discussing these various methods, the author sums up by expressing his opinion that the best motor for fog signal purposes yet tried is undoubtedly the oil engine. Mr. Stevenson, however, points out that the best sound signals are feeble and unreliable, and it is his opinion that the solution of the problem of warning vessels in times of fog will be found in the method proposed by Mr. C. A. Stevenson, in which an electric cable or conductor is laid down off a coast or dangerous place. This would act on an instrument attached to each vessel, and so give warning of the approach to danger.

The discussion on this paper was opened by Mr. Jeremiah Head, who pointed out the great advantages of the petroleum engine for fog-signalling purposes in isolated spots, such as those upon which the installation was usually required. The smaller weight of the

material used, compared to the coal and water of the steam engine, and the quickness with which the motor could be started, were dwelt upon by the speaker.

Colonel CUNNINGHAM pointed out that in many lightships there was no sound signal other than a bell. He considered it desirable to introduce an automatic arrangement of some description. He asked the maximum duration of any fog.

Mr. SENNETT said the paper was of particular interest to him, as mention had been made of the probability of some system of electric cable protection being perfected by means of which vessels could be warned of their approach to the land during fog. He had devised a scheme for this purpose and had just commenced experiments. His system was to produce a sound of known pitch beneath instead of above the water; for this purpose an ordinary siren worked by compressed air, and having independent motion imparted to it, so that it would emit a note of constant pitch, would be suitable. On board the vessel he would arrange an electrical receiving instrument, consisting of a micro-telephonic apparatus tuned in unison with the sound of the warning station. This instrument would be located in a padded cabin, and the officer would listen for the code signal which would give him the name of the station from which the sound emanated. This direction in relation to the course of the ship could be read off by a suitable dial. Mr. Sennett pointed out the great danger in the present system of aerial fog signalling. This was caused by the existence of what Prof. Tyndall had termed acoustic clouds, which are in reality strata of air of various temperatures which had the power of refracting the acoustic ray, tilting it upward so that it failed to reach the vessel. Thus with apparently the same atmospheric conditions a fog signal which had been heard at one hour of the day at a distance of 10 or 15 miles might not be heard at another hour more than 3 or 5 miles. Mr. Sennett pointed out the fact that the velocity of sound in water was some five times as great as in air, and that the disturbing conditions above mentioned did not exist in the sea. With reference to the communication with lightships, the speaker had devised a system in which the signals were given entirely by induction, so that no material or cable connection between ship and shore was necessary. He had only the River Thames to experiment in, and he would be glad to hear of Mr. Stevenson following the matter up, as he had better facilities for working in the same direction.

Mr. DAVID CUNNINGHAM, the Dundee Harbour engineer, said the great advantage of the petroleum engine was that the sound was got directly the fog came on, without waiting to get up steam. They could hear a fog signal for 10 miles under favourable conditions, but the sound was not to be always depended upon for more than a half to a quarter that distance. He had known one case in which a steam yacht had started from the harbour when the siren was in operation, but at the distance of half a mile it could not be heard, although when four miles had been traversed, the sound was again audible.

Mr. WIGHAM said that however good the signals described might be, it was no good for mechanical engineers turning their attention to the matter unless they were adopted. It seemed to him that when a reasonable demand was made by the shipowner to have a danger signal put up, that demand should be attended to, and not refused on the paltry ground of want of money. Two years ago the *City of New York* was within a yard or two of the very rock on which the *City of Chicago* had been recently wrecked. The sudden clearing up of the fog had revealed the danger. At that time the shipowners memoralised for a light to be put on the Old Head of Kinsale, but the request had been refused on the ground of the expense. The speaker considered the gas engine superior to the petroleum engine when gas could be got; in other cases the petroleum engine was best.

Mr. PERRY F. NURSEY gave some very interesting results of his experience with submarine explosions, as bearing upon the conveyance of sound by water.

Mr. SENNETT added that Prof. Hughes had made experiments in Lake Geneva. An ordinary bell was rung under water, and the sound could be heard a distance of nine miles by the aid of a small speaking tube to convey the sound from the water to the listener's ear. While bathing two stones were knocked together, and at a distance of half a mile the noise was so unpleasant when the head was put under water that the experiment was not repeated.

Mr. C. A. STEVENSON, in replying to the discussion for his brother, who was prevented from being present by illness, said that the cost of a first-class installation, such as he had described, was £4,700. The maximum duration of any fog in that district was 80 hours. With regard to the under-water signalling he did not think that the indications would extend for five miles. In the case of a dynamite explosion under water it was not audible at very short distances, whilst it was well-known that divers could not hear the firing of guns. It may be pointed out that neither of these cases are analogous to that quoted by Mr. Sennett.

ON CERTAIN VOLUME EFFECTS OF MAGNETISATION.

By Prof. CARGILL G. KNOTT, D.S.C., F.R.S.E.

(*Read before Section A, August 10th*, 1892.)

THE experiments had to do with the changes of the internal capacity of five iron and five steel tubes, each set having been cut from the same bar and bored to various bores. All had the same length, 18 inches, and the same external diameter, 1½ inch. The iron tubes were distinguished by the Roman numerals I. to V.; and the steel tubes by the corresponding Indian numerals 1 to 5. Tubes of the same number had equal bores. Thus the internal diameter of Nos. I. and 1 were 1¼ inch; of Nos. II. and 2, 1 inch; and so on to Nos. V. and 5, which had each an internal diameter of ¼ inch. Each tube was closed below. When set up for experiment it was closed above by a screw nut through which a capillary glass tube passed, and was then placed vertically in the heart of the magnetising coil. The whole of the metal tube and part of the capillary were filled with water, and the changes of internal volume were measured by the motion of the liquid meniscus in the capillary. In strong fields this motion was easily seen by the naked eye. It was shown at the meeting projected by the lantern on the screen. The measurements were made by means of a micrometer microscope.

The observed changes of volume amounted in some cases to nearly 5×10^{-4} cubic centimetres; and in the narrower-bored and thicker-walled tubes it was evident that higher fields than those used would have produced still greater volume changes. The highest field that could be safely used was 1,400 C.G.S. units.

The general characteristics may be briefly described thus:—In Nos. I., 1 and 2, the effects were very similar, differing only in detail. In low fields the capacity was diminished, in high fields increased. In other words, the graph showing the relation between magnetising force and change of volume began by passing under the line of zero change, then crossed it and continued thereafter above it. In Nos. II. and III. a similar *form* of graph was obtained, only it did not reach the zero line after the maximum decrease was passed. In these cases, as in the case of No. IV., the capacity was always diminished. No. 3 showed increase of capacity in all fields from the lowest to the highest. Nos. 4 and 5 began by showing increase in low fields, but in fields higher than 200 units showed decrease of capacity. A similar but less marked effect was obtained with No. V.; in other words, the graphs of Nos. 4, 5 and V. passed first above the zero line, then cut through it, and passed in almost rectilinear course below it, continuing so to the highest fields attained. The following scheme gives the nature of these changes, *minus* meaning a diminution of bore, *i.e.*, an average contraction of the walls of the tube as a whole, and *plus* an increase of bore or average expansion. By low fields we mean fields of less than 200 units. The numbers are the greatest measured values of the dilatations, or changes per unit volume, and are maximum or minimum values in all the low fields except in the case of No. 3 and No. IV.

Increase of Capacity (*in* 10^{-5} *cubic cm.*) *of Iron and Steel Tubes.*

	Iron tubes.			Steel tubes.	
Nos.	Low field.	High field.	Nos.	Low field.	High field.
I.	− 17	+ 11	1	− 19	+ 42
II.	− 19	− 6	2	− 12	+ 15
III.	− 25	− 26	3	+ 12	+ 40
IV.	− 14	− 51	4	+ 2·4	− 41
V.	+ 0·5	− 32	5	+ 2·3	− 13

The greatest *change per unit volume* was obtained in the case of tube 4. In field 1,000 the dilatation amounted to -4×10^{-6}.

It was necessary to subject the tube to each magnetic field taken first in one direction and then in the other. If this precaution were not taken, the material got into a state of magnetic bias. Very interesting results were obtained when a smaller field was applied after a greater field, the magnetic bias, or "after-effect," due to the larger field having a very pronounced influence. To get rid of this magnetic bias it was sufficient to neutralise the tube by subjecting it to a series of fields of diminishing intensity and alternating direction.

NEW PATENTS—1892.

14,674. "Improvements in electric telephonic transmitting apparatus." A. MARR. Dated August 15th.

14,676. "Improvements in commutatorless direct current dynamo-electric machines." A. CUTHBERT. Dated August 15th.

14,700. "A method of making and using bionomic baths, to mechanico-chemically and hydro-electrically exhalt the health of the people." J. D. MORRISON. Dated August 15th.

14,719. "Improvements in and relating to electrical storage batteries." T. FLOYD. Dated August 15th.

14,720. "Improvements in and relating to electrical storage batteries." A. J. JARMAN. Dated August 15th.

14,738. "Improvements relating to electric arc lamps." C. COERPER. Dated August 15th. (*Complete.*)

14,769. "Improvements in brushes for dynamos." W. P. THOMPSON. (Communicated by H. H. Cherry, S. D. Younglove, L. House, and W. C. Raymond, United States.) Dated August 16th. (*Complete.*)

14,787. "Improved method of soldering aluminium to aluminium and other metals and alloys." J. MANDT and H. HUHNHOLZ. Dated August 16th.

14,799. "Improved electrical switch." A. H. VESEY. Dated August 16th.

14,805. "Improvements in electric arc lamps." H. R. LOW. Dated August 16th.

14,806. "Improvements in motors for alternating currents." H. R. LOW. Dated August 16th.

14,813. "Improvements in electric battery plates." E. P. USHER. Dated August 16th. (*Complete.*)

14,814. "Improvements in storage batteries." E. P. USHER. Dated August 16th. (*Complete.*)

14,815. "Improvements in storage batteries." E. P. USHER. Dated August 16th. (*Complete.*)

14,816. "Improvements in electric battery plates." E. P. USHER. Dated August 16th. (*Complete.*)

14,819. "Improvements in and relating to electric arc lamps." H. WATT. Dated August 16th.

14,822. "Improvements in incandescent electric lamps." H. H. LAKE. (Communicated by E. McOuat, United States.) Dated August 16th. (*Complete.*)

14,833. "A new and improved engine for propelling boats without steam or electricity." H. G. DALLIMORE. Dated August 17th.

14,859. "Improvements in telephonic connections." H. L. T. LYON. Dated August 17th.

14,862. "New or improved apparatus for the production of ozone by means of phosphorus." C. R. POULSEN. Dated August 17th.

14,886. "Improvements in cut-out switches, and cases for containing and protecting the same." A. WRIGHT. Dated August 17th. (*Complete.*)

14,920. "Improved aluminium solder, and method of manufacturing the same." E. GOLL and C. VATCKY. Dated August 18th.

14,945 "Improvements in the manufacture of chlorine." H. W. WALLIS. Dated August 18th.

14,946. "Improvements in the manufacture of chlorine." H. W. WALLIS. Dated August 18th.

14,947. "Improvements in the plates or electrodes of electric storage batteries." A. J. JARMAN. Dated August 18th.

14,974. "Improvements in electric measuring instruments." W. T. GOOLDEN and S. EVERSHED. Dated August 19th.

15,002. "Improvements in telephony or means for transmitting telephonic signals through long distances." J. HINES. Dated August 19th.

15,035. "Improvements in automatic switches." J. H. RIDER. Dated August 20th.

15,038. "Improvements in electrical winding mechanism for clock movements." A. E. VIDAL and G. HERVIEW. Dated August 20th.

15,057. "Improvements in electric arc lamps." J. BROCKIE. Dated August 20th.

15,059. "Improvements in portable electric incandescent lamps and in battery cells and fittings therefor, also partly applicable to electric batteries generally." H. C. GOVER. Dated August 20th.

15,066. "Improvements in electrical cut-outs for high tension currents." C. E. WEBBER and G. H. NISBETT. Dated August 20th.

15,083. "Improvements relating to the manufacture of aluminium fluoride." L. GRABAU. Dated August 20th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

3,426. "Improvements in brushes and brush-holders for electric machines." H. J. DOWSING. Dated February 25th. The inventor makes a separate handle or clip, consisting of a plate or plates of suitable material of such form that it will fit and move up and down in the ordinary brush-holder attached to the machine. At the lower end of this holder he forms a clip of a suitable form with arrangements for holding firmly and making good contact with one end of the wearing brush. By this means the part that wears can be removed when necessary, and easily replaced. 1 claim.

3,738. "Improvements in and apparatus for electrolysing and bleaching." J. MARX. Dated March 2nd. The object of the invention is to provide improved means for use in electrolysing substances yielding soluble products, without the use of a diaphragm, and also for bleaching. The apparatus employed is filled, for example, with an alkaline chloride, and when the electric current is passed therethrough hydrogen and chlorine develop, and the base (or caustic alkali) remains in solution. The base and the chlorine tend to recombine, but, owing to the electrodes being low, the gas evolves quickly, and only a small part of it can recombine to form an alkaline hypochlorite. This hypochlorite solution is exposed to carbonic acid, when free hypochloric acid forms. This liquor is electrolysed again, or repeatedly, in the same or in a series of the apparatus. 4 claims.

4,579. "Improvements in switches for electric cigar lighters and like purposes." G. BINSWANGER and C. H. SMEETON. Dated March 14th. Consists of an iron, steel, or other metal tube closed in at each end, divided into two or more parts, by means of sleeves or nipples made of ebonite or other electrical insulating materials, thereby insulating the metal parts from each other. Each part is fitted with a terminal or binding post for making the necessary contacts or attachments; the tube is partly filled with quicksilver for the purpose of making the necessary automatic electrical contact when in use. The switch is fitted in a wooden or china handle in such a manner that when hung upon a hook or suspended in a certain position, the quicksilver falls to one end of the tube switch; when taken from that position the quicksilver falls to the other end of the tube switch. 2 claims.

5,003. "Improvements in holders or supports for incandescence electric lamps." J. Y. JOHNSON. (Communicated from abroad by Mace, of Holland.) Dated March 20th. According to this invention the barrel or body part of the holder or support is made of vitrite or other material not liable to be injuriously acted upon by corrosive gases or by damp. The contacts between the lamp and the holder and support, and the connections with the external wires, are made inside the said barrel or body part, which is closed in so as to prevent access of gases, water or other deleterious matter. 3 claims.

10,840. "Improvements in electric clocks." G. L. J. VAN DER PLOEG. Dated June 25th. Consists mainly of a compensated pendulum swinging in an air-tight case, and a clock-work connected with the former by means of electric conductors. 2 claims.

14,702. "Improvements in or connected with accumulators or secondary batteries." H. HAUSER. Dated August 31st. Every plate or electrode is composed of several horizontal honey-combed plates, made of a suitable metal or alloy. The holes in the most suitable shape are open only to the upper side, and are filled with the active material of the desired kind. These honey-combed plates are connected up by a frame of a suitable metal or alloy; the compound plate so formed being somewhat similar to a book-case. 3 claims.

14,911. "Telephone receiver supports." W. N. MARCUS. (Under international convention.) Dated February 10th. Consists in an adjustable bracket, which bracket may be placed on the wall of the room in which the telephone is placed, and the object of the said invention is to dispense with the necessity of holding the receiver in hand, leaving the hand free for other use, thus avoiding the fatigue of holding the receiver. 1 claim.

CORRESPONDENCE.

Contribution to the Chapter on Accumulators.

In No. 767, August 5th, 1892, of your widely read journal, your correspondent has unfavourably criticised a circular which we have recently issued to owners of our batteries and has questioned the value of our guarantees because the same are dependent on the instructions which we issue being observed. In his opinion the confidence of the public in our accumulators will be shaken, since the instructions to be observed are not specified in the circular.

With reference to these points allow us to remark :—

(1.) Since the circular in question was only sent to owners of our batteries who were handed full instructions for management at the time of ordering the battery we did not consider it necessary to again specify these.

(2.) The instructions for management are not to be confused with our book on "Besrhorebung, Aufstellung Behandlung di Schaltung von Accumulatoren." The latter contains 190 pages describing fully the work of the erector in *putting up* the cells and the different portions of them, also the precautions to be observed in coupling them to the dynamos and the various ways of doing this. The former consists of only 35 lines of printed matter made up of short paragraphs relating to current density and voltage, and containing full instructions concerning the management of accumulators when *in work*.

(3.) Our circular is thus merely a reminder addressed to owners of batteries of our make, asking them to fulfil those obligations relating to the looking after the batteries, which they agreed to on taking over the same, and on which our guarantee rests.

(4.) From the above no reasonable person could come to the conclusion that our guarantee is worthless, but rather would he again confide in the working of accumulators, as in issuing precise instructions to guide the purchaser, we point out to him the best means of greatly prolonging the life of his battery.

We should certainly feel that we had failed in our duty to our customers, if we did not clearly explain to them the proper way of handling the batteries so as to make them last as long as possible.

We trust our explanation will satisfy your correspondent and set at rest any misgivings which he or others may have had as to the reasons of our issuing the circular.

For your and your correspondent's information, and as a proof of our assertions, we enclose you a copy of our book on "Erection, Working and Coupling of Accumulators," as well as two copies of our working instructions, to which latter the circular in question referred.

Accumulatoren-Fabrik Aktien-Gesellschaft
Generalrepraesentanz Wien,
Dr. G. STRICKER.

Wien, *August 27th.*